SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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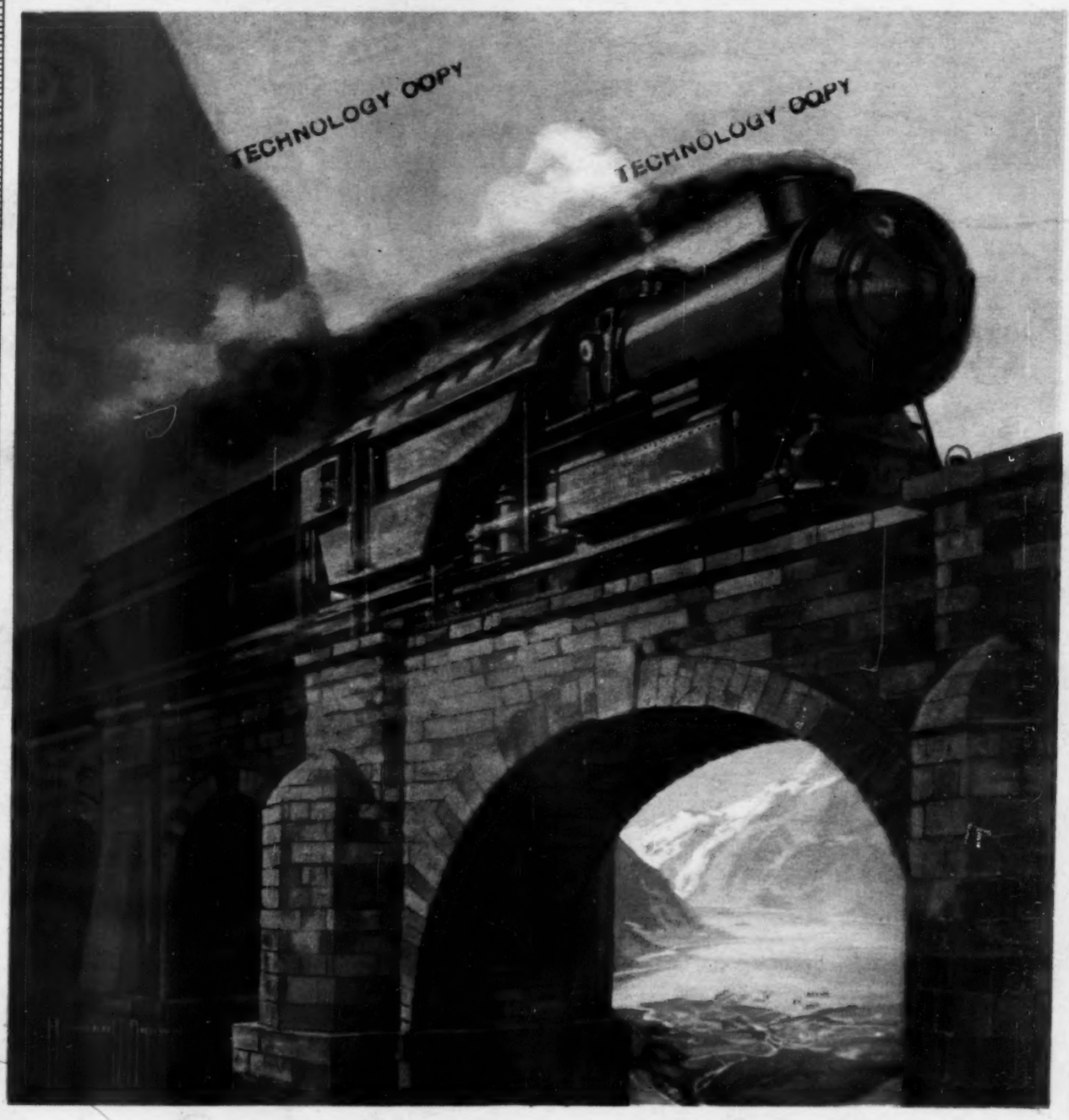

PUTTING THE STEAM TURBINE ON WHEELS: SWEDEN'S LOCOMOTIVE OF REVOLUTIONARY DESIGN.—[See page 91]

Scientific American Publishing Co., Munn & Co., New York

These 93 Branches
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All of the American cities indicated on the map above are the homes of International branches, the regional centers of International Harvester activity. The branch house illustrated is typical of the ninety-three. Together they assemble a floor space of more than 140 acres.

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Ninety-three International branch houses, strategically located as shown by the map, supply the 15,000 dealers and serve as links between them and the International factories. These are the vital centers in the network of International service. At every International branch house is a completely equipped motor truck service station, in charge of highly-trained specialists and road engineers whose single purpose is to safeguard the performance of International Motor Trucks, and among them the vast fleet of "Red Babies."

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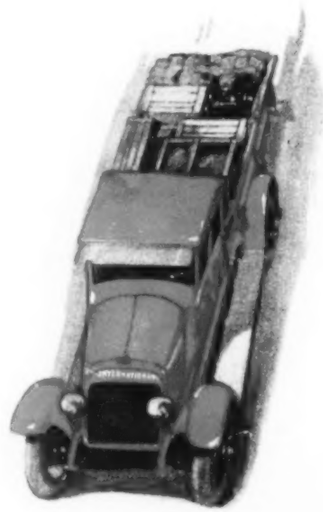

INTERNATIONAL HARVESTER COMPANY

CHICAGO OF AMERICA (INCORPORATED) U S A

International Motor Trucks for Low-Cost Hauling, 2,000 to 10,000 Pounds Capacities

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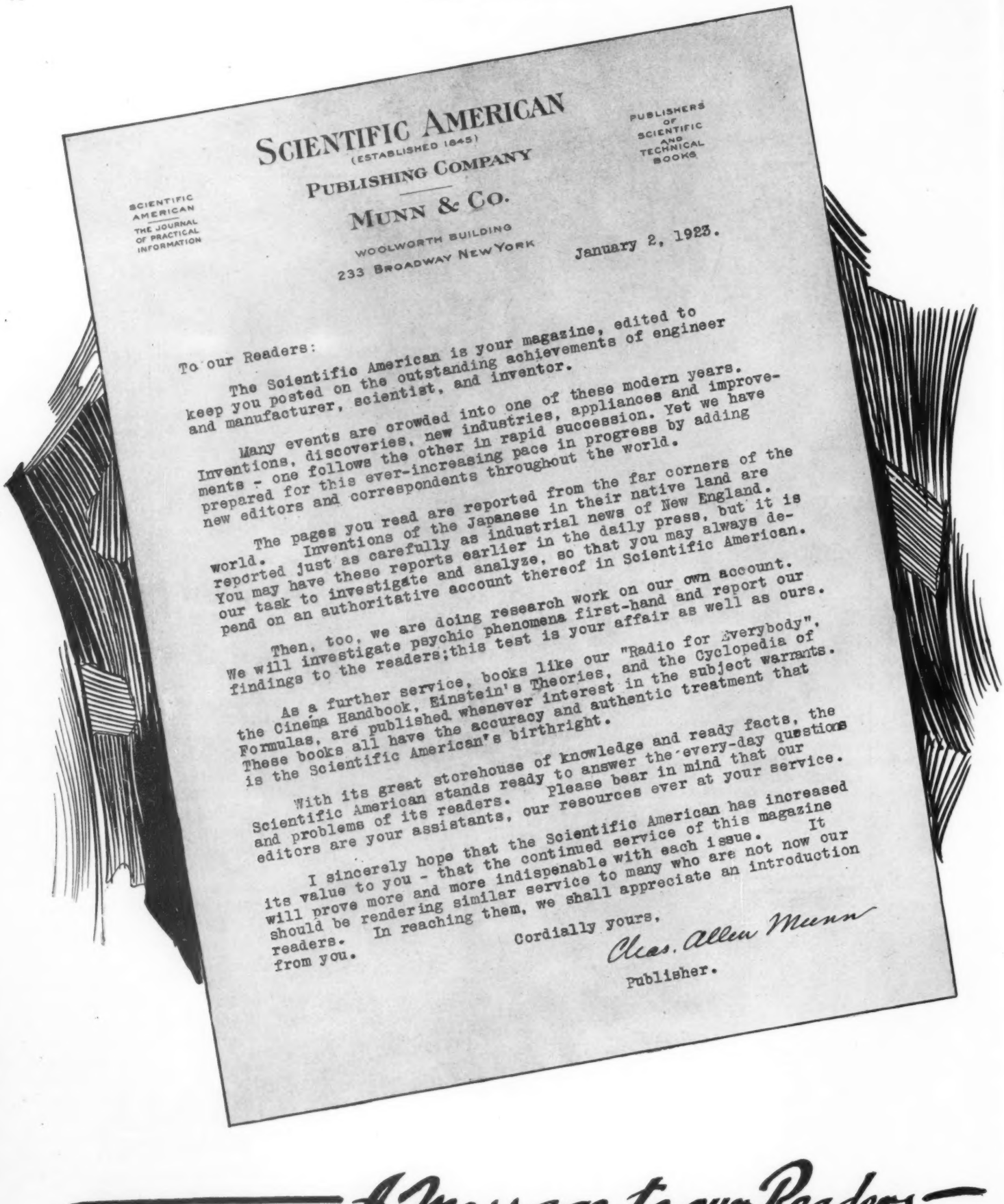

SCIENTIFIC AMERICAN
THE JOURNAL OF PRACTICAL INFORMATION

SCIENTIFIC AMERICAN
(ESTABLISHED 1845)
PUBLISHING COMPANY

PUBLISHERS OF SCIENTIFIC AND TECHNICAL BOOKS

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233 BROADWAY NEW YORK

January 2, 1923.

To our Readers:

The Scientific American is your magazine, edited to keep you posted on the outstanding achievements of engineer and manufacturer, scientist, and inventor.

Many events are crowded into one of these modern years. Inventions, discoveries, new industries, appliances and improvements - one follows the other in rapid succession. Yet we have prepared for this ever-increasing pace in progress by adding new editors and correspondents throughout the world.

The pages you read are reported from the far corners of the world. Inventions of the Japanese in their native land are reported just as carefully as industrial news of New England. You may have these reports earlier in the daily press, but it is our task to investigate and analyze, so that you may always depend on an authoritative account thereof in Scientific American.

Then, too, we are doing research work on our own account. We will investigate psychic phenomena first-hand and report our findings to the readers;this test is your affair as well as ours.

As a further service, books like our "Radio for Everybody", the Cinema Handbook, Einstein's Theories, and the Cyclopedia of Formulas, are published whenever interest in the subject warrants. These books all have the accuracy and authentic treatment that is the Scientific American's birthright.

With its great storehouse of knowledge and ready facts, the Scientific American stands ready to answer the every-day questions and problems of its readers. Please bear in mind that our editors are your assistants, our resources ever at your service.

I sincerely hope that the Scientific American has increased its value to you - that the continued service of this magazine will prove more and more indispenable with each issue. It should be rendering similar service to many who are not now our readers. In reaching them, we shall appreciate an introduction from you.

Cordially yours,

Chas. Allen Munn

Publisher.

A Message to our Readers

With the Editors

WRITERS are an interesting study. For one thing, they do not run true to type. There are almost as many types of writers as there are writers, and practically every writer has his own individual way of going after facts and weaving them into an article or story. Then again, there are writers who write for a living, and there are writers who write for the thrill of seeing their expressions in print. There are various qualifying grades of writers ranging from quite excellent to very poor, and from absolutely reliable to absolutely unreliable. There are writers who are ever ready to write about anything worth writing about, and there are non-writers who have invaluable facts but do not possess the necessary ability to write them up in an understandable and readable form. There are writers who confine their efforts to one definite field and there are writers who write on anything and everything. There are writers who call on the editors, talk over various contemplated subjects, and, upon receiving a definite order for a given article, go out after the facts and prepare their contribution "on order" instead of merely "on speculation." Other writers write up everything and anything, turning out vast numbers of manuscripts which they pour into the editorial rooms of the various periodicals in an endless stream. Truly, writers are an interesting lot.

FORTUNATELY for us, there are certain writers who confine their efforts to scientific subjects. Many of these writers have had an engineering training and, later on, have turned to writing either as a vocation or an avocation. They know science, understand it from the technical as well as the popular standpoint, and have the happy knack of translating involved technical facts into plain, everyday, readable English, without loss of authenticity. While much of our material is received from a small group of regular contributors and correspondents abroad, we hasten to explain that *all* articles are at *all* times considered purely on their merits. In our field, unlike the fiction field, names of authors mean little in comparison with the articles themselves. The reliable and competent contributor with a good story to tell and who has told that story well, will meet with as prompt acceptance at our hands as one of our regular contributors and correspondents of many years' standing.

AMONG our month-to-month contributors none is more interesting than Dr. E. Bade, who writes on natural science subjects. Dr. Bade is a trained scientist and a highly specialized writer. He creates his own facts through his own investigations. Out at his home in Glen Head, Long Island, he has every facility for studying all kinds of plant and animal life and making photographs of the more interesting phases. In fact, his striking photographs showing greatly enlarged insects in life-like poses, have attracted such wide-spread attention that we felt called upon to secure a description of the simple but effective photographic apparatus employed by Dr. Bade in making his interesting "close-ups." On page 97 of this issue Dr. Bade describes his "macro-photographic" camera, as he calls it. This ingenious arrangement may be applied in many interesting ways, such as in the photographing of natural science subjects, manuscripts and documents of all kinds, small objects or small sections of large objects, textiles, and so on.

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FEBRUARY, 1923

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SHORTER ARTICLES

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PROBLEMS of page architecture are ever with us, and they take up a larger share of our time and energy than is perhaps realized by the reader who sees only the finished product of our planning and of the printer's and engraver's execution. The worst feature of these problems is that often they won't stay settled. For instance, last month, in the case of the two pages destined to carry the statement of the conditions of the psychic contest and the portraits of the judges, we thought the matter was entirely off our hands with the decision to arrange the portraits down the outsides of the facing pages. But when we came to measure up the photographs, some of which reached us very late indeed, we found that these were of such shape as to leave much more white space above and below than we had anticipated. So at the last moment, without the slightest possibility of consulting the gentlemen themselves, we had to scurry about in search of further biographical details that would serve as a basis for enlarging the captions from the intended two or three lines, to the nine lines each which were necessary.

SO the foregoing state of affairs explains why it is necessary to come forward at this late date with a correction of one of the statements made about Dr. Comstock. He has not been connected with Massachusetts Institute of Technology continuously since 1904. Our statement to this effect was the result of our failure to note the ambiguity of a rather puzzling entry in *Who's Who*. The fact is, that from 1905 to 1907 Dr. Comstock was studying in Basle, Zürich, Berlin and Cambridge, and that the unbroken sequence of dates set down in *Who's Who* for his connection with "Tech" is necessarily incorrect. At the same time, Dr. McDougall's alternate asks us to explain to our readers that we conferred the title of "Doctor" upon him a trifle prematurely. We knew that at the time of writing and going to press, he was passing through the mill that turns out Ph. D.'s, and we anticipated that he would be completely turned out before our issue was in the hands of the readers. The fact is, he will be "Dr. Murphy" by the time he is called upon to do anything for our committee, but at the same moment he is more or less in the position of having been elected but not yet initiated.

AMONG the many interesting articles which are coming along in early issues is one describing the remarkable innovations in housing construction now being introduced by Ernest Flagg, the well-known architect. Perhaps it is best to add that Flagg is that resolute and implacable artist from whose drawing board sprang the first of the great towers that grace Manhattan's skyline — the Singer Building. He is the designer of the Naval Academy at Annapolis and of the many fine architectural works such as the Corcoran Art Gallery at Washington, D. C. So it is evident that Flagg is one of our great architects, and that his latest efforts along the line of producing better and more attractive small homes for the least amount of money, are worthy of our careful consideration. Flagg has developed a new method of building beautiful masonry walls by means of wooden molds and common labor, and at a cost that seems unbelievably low. Yet this method is now being used, and as a consequence Flagg houses are being built at little over half the accustomed cost.

Caterpillars are made in sizes suitable for trucks of every type and weight

Has used *Caterpillar tires for three years

Three years is not a very long time but it is long enough for a truck owner to find out whether or not a tire will give him the kind of service he wants.

The Goodrich Oil Co. of New Haven, Conn., after using *Caterpillars for three years has written us the following letter which speaks for itself:

> "Our experience with the Kelly Caterpillar tire has been nothing but the best. We have used them continuously for the past three years in Rhode Island and can say nothing but praise for traction, resiliency and service, as we do not know what adjustments are. We operate six trucks in Rhode Island all equipped with Caterpillars and would recommend them for any kind of service.

Caterpillars get traction without chains, cushion the truck without punctures or blowouts, and give long, economical mileage.

The longer a truck owner uses *Caterpillars the better he likes them.

**U. S. Government tests show that Cushion Tires are 50% easier on roads than are solid tires. Caterpillars are an advanced type of cushion tires.*

There is no *Caterpillar Tire but the one that Kelly makes

KELLY-SPRINGFIELD TIRE COMPANY

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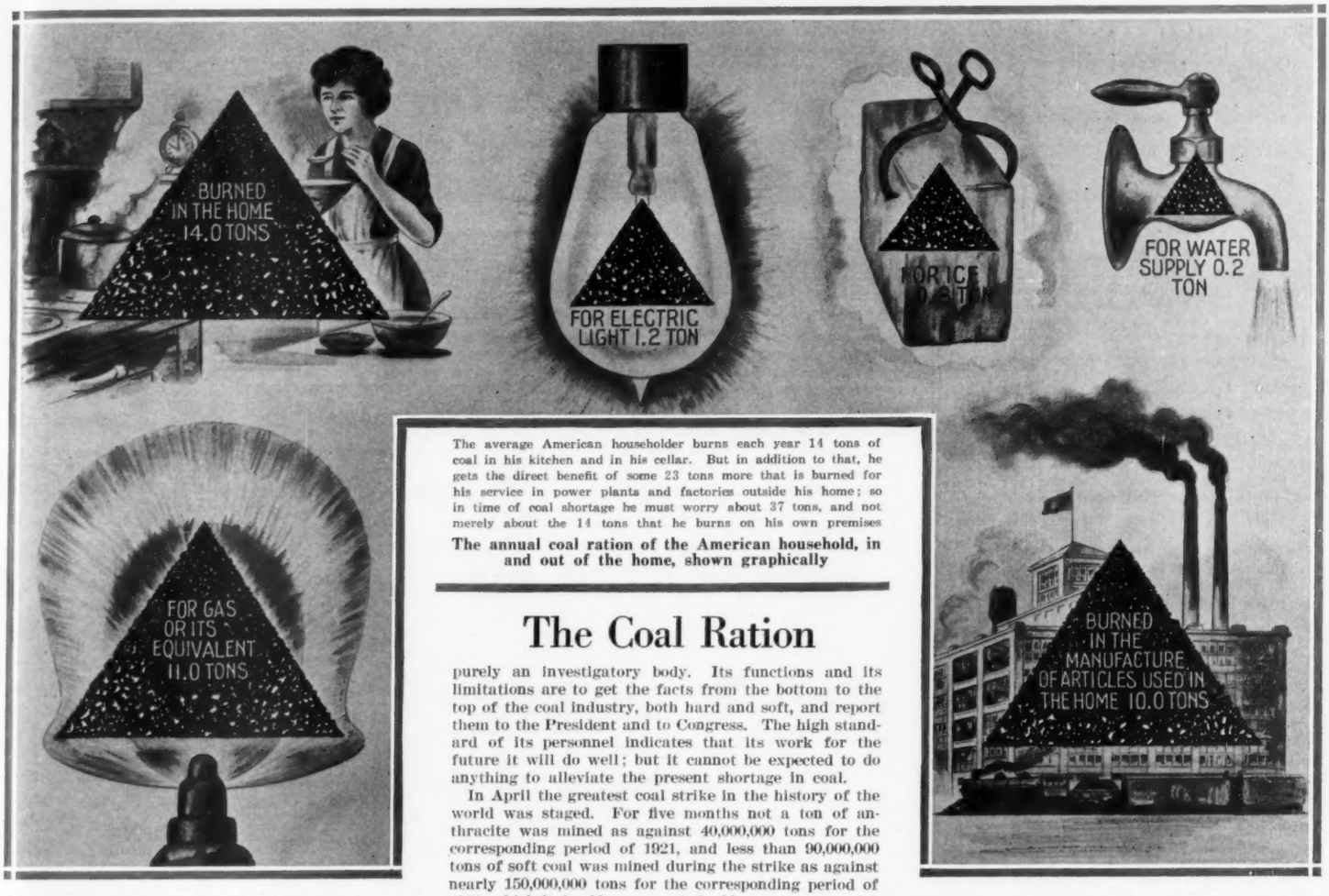
250 WEST 57th STREET NEW YORK, N. Y.

SEVENTY-NINTH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, FEBRUARY, 1923



The average American householder burns each year 14 tons of coal in his kitchen and in his cellar. But in addition to that, he gets the direct benefit of some 23 tons more that is burned for his service in power plants and factories outside his home; so in time of coal shortage he must worry about 37 tons, and not merely about the 14 tons that he burns on his own premises

The annual coal ration of the American household, in and out of the home, shown graphically

The Coal Ration

WE ARE told that if we will install certain fixtures in our furnaces we can burn the small, cheap sizes of buckwheat, rice, and barley anthracite which are sold at much lower prices than the larger, hand-picked sizes. Another circular announces some sort of stuff to mix with coal which would give it 40 per cent more efficiency. Other advertisements urge the installation of oil-burning paraphernalia. These and many more schemes, some legitimate and others frauds, are riding in on the wake of the coal shortage and high prices. They are all beside the main question, mere catchpenny palliatives for a serious disease. If enough people install apparatus for burning buckwheat and other steaming sizes of coal to appreciably increase the demand the prices will immediately go up. During times of shortage in a commodity many substitutes will be offered and many saving devices will promise to pay for their cost within a short time. But during such periods of stress is a poor time to test out innovations. They are apt to be more costly than even the increased price of the real article.

President Harding's Coal Commission as organized in Washington is beginning to get into action. It is purely an investigatory body. Its functions and its limitations are to get the facts from the bottom to the top of the coal industry, both hard and soft, and report them to the President and to Congress. The high standard of its personnel indicates that its work for the future it will do well; but it cannot be expected to do anything to alleviate the present shortage in coal.

In April the greatest coal strike in the history of the world was staged. For five months not a ton of anthracite was mined as against 40,000,000 tons for the corresponding period of 1921, and less than 90,000,000 tons of soft coal was mined during the strike as against nearly 150,000,000 tons for the corresponding period of 1921, which in itself was a period of low output—a total deficit of approximately 100,000,000 tons. During fully two-thirds of the strike period the coal miners and the operators sat tight and the public lolled back indifferently, hardly recognizing that there was a strike on. Then the stored coal began to run low, and with no sign of a break in the strike the manufacturing public began to wake up. But the weather was warm and the average householder still dozed. He did not begin to get really warmed up on the subject until he was physically almost chilly. Finally with empty coal bins in his cellar he arose in some majesty and demanded action—various and drastic action: that the strike be stopped, that Congress enact a law preventing future coal strikes, or a law to force the Government to take over the coal mining industry—anything to fill his cellar with coal and keep down the cost of his coal. "Why didn't the President do something; why didn't Congress do something?" was the oft-heard cry. And had it not been for the cooler and steadier heads among both operators and miners and especially those representing the public we might indeed have had ill-considered and drastic action, the serious outcome of which can hardly be imagined.

What the average man, with a furnace, or a coal stove, has utterly failed to recognize is that his home supply of coal is a very small portion of the coal problem, but that the larger part of the problem is just as much his own as is that of filling his personal bin at a reasonable cost—the invisible coal that he consumes. The cost of this invisible coal enters into practically everything that the average man, his wife, and his children, use. Our annual consumption of coal is about six tons for every man, woman and child, and less than one and one-half tons of this are used for heating and cooking. We may quite overlook the large amount of coal that goes into each house over the electric wire, through the water pipes and in other ways. A study of a single household whose coal purchase was 14 tons of anthracite during the year shows an almost equal consumption of bituminous coal which was not seen by any member of the household but for which that household had to pay just as truly as for the 14 tons of anthracite purchased and burned on the premises. It was burned, for the benefit of that household, at the power station for working electric current, at the ice factory for making ice, at the gas plant, and at the

(Continued on page 142)

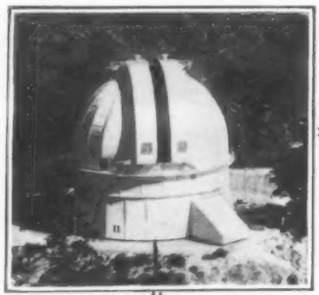
The Census of the Stars

How the Astronomer Takes Count of Their Number, and Identifies Them Individually

By Professor Henry Norris Russell, Ph.D., Princeton University

MARK TWAIN tells a tale of an astromoner who was approached deferentially by an old gentleman with the query: "There is one thing about you astronomers that I cannot understand. I see how you can count the stars. I have some idea how you can tell how far off they are, and even what they are made of. But the thing that greatly puzzles me is this: How ever did you find out their names?"

We all smile at this: but it remains a bit of a puzzle to the average man how the astronomers can name and catalog the stars so thoroughly that a few words in a letter or telegram will tell any student of the science just what star out of the many millions in the heavens is meant. The thing is really very simple—and much like the system by which the post office takes our letters and secures their delivery to any inhabitant among the hundred millions and more in the country. It is still more similar to the method by which the artillery were enabled to describe the exact position of their objectives within the enemy lines. But to tell the story fully we must begin long ago and far away.



PROFESSOR RUSSELL has, for some years, been telling our readers each month what the astronomers are doing. He has not had the space to tell how they do it, nor has it been in accord with the spirit of his monthly article to attempt this, save in rare cases like that of the Michelson interferometer, where a wonderful instrument has been newly invented and his story has been distinctly of this instrument. It has occurred to us, however, that the majority of our readers are probably considerably in the dark as to the actual way in which the astronomer goes about his work—the tools he uses and what he does with them. So we decided, and Dr. Russell agreed with us, that a series of articles on the astronomer's ways and means would be of interest to the SCIENTIFIC AMERICAN *public. The present story is the first of the series, which will run to four parts or more, according to the amount of space which the tale occupies as it flows from the professorial pen. Before he is through, Dr. Russell will have given you a clear idea of just what equipment the astronomer employs, just where he employs it, just what he does with it; and the bearing on his story of the two bits of observatory construction whose pictures adorn this page will have been made more clear than it can be, in the very nature of the case, from the present installment.*—THE EDITOR.

It is probable that, as soon as men began to pay any intelligent attention at all to the stars, they must have noticed some of the conspicuous groups in which they occur in the sky, and given them names. The compact cluster of the Pleiades, the row of three bright stars which we know as the belt of Orion, the great square of Pegasus, and several other configurations, could hardly fail to catch even the casual eye. As time went on, more and more of these groups were given names and recognized as constellations.

The oldest names are those of animals, and most of these are so old that we cannot date them; they go beyond recorded history. Where they originated, however, we can be fairly sure—it must have been in western Asia, and very likely in Mesopotamia or Syria. The animals of the constellations are just the animals of the Bible—the bull, the ram, the goat, the greater and lesser dogs, the lion, two bears (she-bears, both), the wolf, the eagle, the swan, the raven, the dove, the serpent, the fishes, the crab, the scorpion. There is no tiger, no elephant; hence our constellations were not invented in India. Nor did they originate in Egypt, for there is no crocodile and no hippopotamus. It is rather surprising that there is no pig. The Chinese have an independent set of constellations, totally different from ours; and that rules them out as the source of ours.

Very few of the star-groups look at all like the beasts they are supposed to represent. The scorpion is a striking likeness, the lion and the great bear can be made out by a little imagination, as can the swan, flying up the Milky Way. Almost all the rest are hopeless.

Next in order of age come the mythological figures—strange beasts like the Dragon, the Centaur and Pegasus, or fabled heroes such as Perseus, Hercules and Orion. These constellations all have Greek names—though some of these may have displaced older originals. Along with them may be placed the Ship Argo.

These conspicuous groups do not fill all the heavens, and names were later given to the less prominent intervening regions. Thus the Balance was introduced into the Zodiac, breaking the list of living things therein, to make twelve constellations for the twelve months of the year. A good deal of unappropriated territory remained, however, until three or four centuries ago, when the remaining gaps were filled by the introduction of new beasts, such as a giraffe in the northern sky and a flying fish in the southern; and of the scientific instruments of that day—a sextant, an air-pump (Antlia), a telescope, and so on. These modern constellations are inconspicious, except near the south pole, among the stars which the ancients could not see. The only well-known one is the famous Southern Cross.

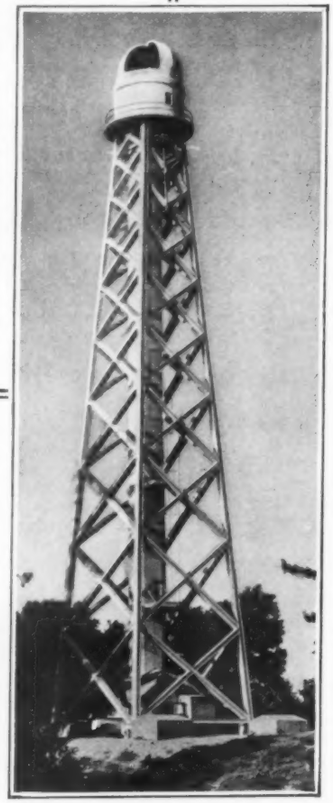
It may be added that there is one really American star-group—the Great Dipper. When and where this term for the bright group in Ursa Major originated is obscure; but it is practically unknown in Europe, where the same group is usually called the Plough in England and the Wagon in Germany. So we may fairly claim it, along with the Little Dipper, including the Pole-Star, and the Milk Dipper in Sagittarius, as a Yankee invention. Apparently the dipper plays a greater role in the rural life of America than of Europe.

Having named the constellations, the ancients used to refer to individual stars as "the Dragon's right eye," "the star on Orion's right shoulder," and so on. Some of the brighter stars had names of their own. A score or so of these are still in use; some of classical origin, such as Sirius, Procyon, Canopus, Arcturus and Antares; others coming from the Arabic—Betelguese, Altair, Algol. We still speak, too, of the belt and sword of Orion, the head of Aries, and the tail of Scorpio. But in general this nomenclature is hopelessly complicated. A vast improvement was made in the year 1603 by Bayer, who took the brighter stars of each constellation and assigned to them the successive letters of the Greek alphabet—usually in order of brightness. The brightest star in the constellation Leo is therefore called Alpha Leonis (Alpha of the Lion); the next brightest Beta Leonis, and so on. The Latin names of the constellations are used in this case, as in others, by international agreement. The French held out for constellation names in their own language until the present year, when their representatives at the Astronomical Union in Rome voted to fall in with the majority.

This scheme takes care of all the naked-eye stars in small constellations such as Lyra or Delphinus, but not for large ones like Draco or Cygnus. For the rest of the stars in these constellations we usually employ the numbers given by Flamsteed, early in the eighteenth century, which included all the fairly bright stars in the constellations, in order from west to east. Thus we speak of 61 Cygni, 37 Pegasi, and so on. We have now a simple name for every star that is comfortably visible with the unaided eye. To find such a star, we need only have a star map upon which the stars are plotted, with indication of their brightness and the constellation boundaries, and with the Greek letters and Flamsteed numbers shown. By comparing such a map with the sky, we may pick out our star, just as an airman with his map picks out a spot on the ground below him.

But what can be done with the vast multitude of telescopic stars? Here it pays to forget what has already been done and start afresh, describing the star by its apparent position in the heavens and, as a further aid in identification, by its brightness.

We may speak first of the latter. The brightest stars were known to the ancients as "stars of the first magnitude"; then came those of the second magnitude like the Pole-Star, of the third, the fourth, and so on down to the sixth, which were so faint that the eye could barely detect them. Stars visible only under the telescope are described as of the seventh magnitude, eighth magnitude, etc., in order of increasing faintness. Measurements show that a first magnitude star is 100 times as bright as one of the sixth magnitude—that is, a difference of five magnitudes corresponds to a change of light by a hundredfold. Hence a star 100 times fainter than the faintest visible to the naked eye is said to be of the eleventh magnitude; one 100 times fainter still is called a sixteenth magnitude star; and so on. For purposes of identification the astronomer needs only to know the star's magnitude, roughly, so that he can tell how large a telescope he will have to use to see it, and about how bright it ought to look.



To describe where the star seems to be in the sky the astronomer uses a system exactly like that which the geographer uses to locate scattered islands and rocks at sea. There are poles in the heavens—about which the sky appears to turn every day, to us who live on a rotary planet—and an equator half way between them. The distance of a star from the celestial equator (measured of course in degrees and fractions as all apparent distances in the sky have to be) is just like the latitude of an island in the ocean. It happens to be called by a different name—declination; but it runs north and south of the equator in the same way. Similarly we choose a stationary point on the celestial equator (the vernal equinox), and reckon east from it, just as we count our longitude from the meridian of Greenwich on the earth; though in the sky we call what we get in this way by the old and clumsy name of right ascension, which once meant something slightly different.

The right ascension and declination of a star define its place in the sky, just as the latitude and longitude define a position on the earth; and the astronomer has his catalogs and charts of stars, just as the mariner has his lists and charts of islands and shoals. In both cases the position of the object is found by suitable observations, and the maps and charts are made by plotting the observed positions.

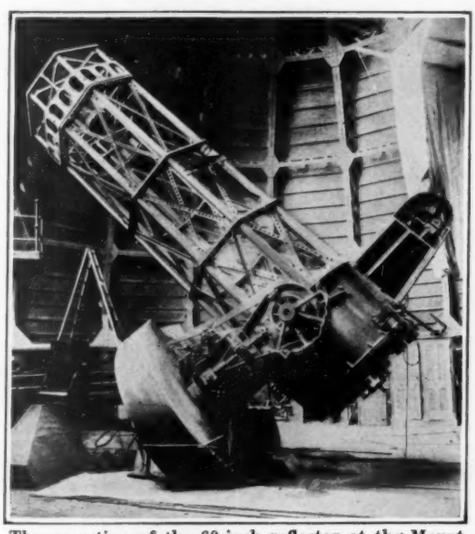
To get his star-catalog the astronomer begins by

setting up a telescope, which he calls a meridian circle, because it has a very accurate graduated circle attached to it. Telescope and circle turn on two very accurate bearings, exactly on the same level and in an east-and-west line, so that the instrument can be made to point successively to the northern horizon, the pole, the zenith and the southern horizon. The exact angle through which it is turned in swinging from one object to another is read on the graduated circle by microscopes. If we know the circle reading on the equator and that on any star, the difference of the two will tell us the star's distance from the equator, or its declination. Now we cannot see the equator to sight on it; but it is just 90 degrees from the pole. We cannot see that either; but the Pole-Star (which is not exactly at the pole, but close to it) can be observed when it is right above the pole, and again, half a day later, when it is directly below it. The average of the two circle readings which we get in this way is the reading on the pole: and the problem of declination is solved.

To get our right ascension we need an accurate clock, properly regulated. Then we note the clock time at which a star (carried by the apparent rotation of the heavens) crosses the middle of our telescopic field, marked by a fine spider-line. The difference between the times at which any two stars cross measures the difference between their right ascensions—very much as the corresponding difference in the times when the sun crosses the meridians of any two places on the earth measures their difference in longitude. Our starting-point of measurement, the vernal equinox, can be found by observing the sun; and we have then all the material necessary to put the stars in our catalog, or on our chart.

More interesting, perhaps, than this bare outline of the method are the details by which the utmost possible accuracy is insured. Every adjustment of the instrument is set as nearly right as can be, then clamped firmly; and the small outstanding errors of every one are then measured and allowed for. For instance, a very delicate spirit level, set across the pivots on which the axis rests upon which the telescope is rotated, tells us how much these deviate from being exactly on the same level. Though the graduations of the circle are engraved with the utmost precision known to engineering, the minute errors in their positions are found by long series of microscopic measures, and allowed for. The clock, upon which so much depends, is mounted upon a firm pillar in an underground room, kept always at the same temperature, and enclosed in an air-tight case in which a partial vacuum is maintained—lest, when the barometer falls, the diminished fraction of the rarified air should let the clock run faster!

Almost countless other precautions are needed before the results of observations can be regarded as meeting the severe modern standards of high precision. When these conditions are met, a single observation will give results which are more likely than not to be correct within 0.3"—that is, within a twelve-thousandth part of one degree, or a four-millionth part of the circumference of a whole circle. Even so, three or four observations are made on different nights, and the average taken, to obtain the position given in a modern star-catalog.



The mounting of the 60-inch reflector at the Mount Wilson Observatory

When the navigator has once found the latitude and longitude of an island, the work is done for good and all. But the astronomer has no such luck. To begin with, the equator is shifting its position in the heavens, and the equinox with it, on account of the slow shift in the direction of the earth's axis (like that of the axis of a top spinning in an inclined position). From our observations themselves (comparing recent ones with those made many years ago) the rate and direction of this shift of the equator can be found; and it is then easy enough to correct our star observations to allow for it. But to carry out the numerical calculations for thousands of stars is a weary task, though made somewhat easier by tables.

Finally, when this correction has been made, it is found that the stars themselves are in slow motion in various directions. If we have good observations covering fifty years or more, these "proper motions" can be determined and allowed for.

Our star-catalog, therefore, gives not merely the star's brightness, and its right ascension and declination at a given time; but also the rates at which these last two change per year owing to the motions of the equator and of the star—and, indeed, even the amounts by which the annual rates of change will themselves alter after a century, so that allowance may be made for them with all precision.

Such a catalog is dreary reading, indeed—a vast waste of figures, with but a few printed words at the top of the columns; but few books cost more labor to prepare, or even to print—for in such a work errors are inexcusable, and the proof-readers have a hard time. Nevertheless, the library of any properly equipped observatory must contain dozens of such catalogs. The total number of stars which have been accurately observed during the past century and a half runs up to nearly, if not quite, a hundred thousand; and the recorded results of these observations form part of the invested capital of astronomy. They must represent, from the financial side alone, a total cost, mainly in the salaries of the workers, of a couple of millions of dollars.

Part of a typical sky photograph, with its stars of all grades

What is the use of so huge a labor, and why do astronomers continue it? In the first place, almost all our knowledge of the proper motions of the stars has been obtained by comparing earlier and later catalogs; and from these motions we have learned facts about the distances of the stars, and their distribution around us in space, which we could hardly have got in any other way. Secondly, the many stars with well-determined positions serve as points of reference for future measures. The discoverer of a comet, for instance, has only to find a nearby "known" star, and measure how far the comet lies east or west and north or south from it, to find where the comet is in the sky—just as a mariner locates himself on the chart by the bearing and distance of a lighthouse whose position is known.

Besides these accurate catalogs there are others, giving the positions and brightnesses of a much larger number of objects, but with low precision, sufficient only for purposes of identification. Such "Durchmusterung" catalogs, as they are called from the original one, made by the German Argelander, now cover the sky from pole to pole, and contain almost a million stars. For the whole northern hemisphere of the sky, and to 23 degrees south of the celestial equator, the positions of all the Durchmusterung stars have been plotted on charts—another tremendous task, producing results of inestimable value to the astronomer.

When once a star has been cataloged, an astronomer may refer to it simply by its number in the catalog. Thus Lalande 21,185 means the star bearing this number in Lalande's catalog (made about 1790). By reference to this catalog the observer may find the right ascension and declination of the star, and then point his telescope at it. A star will often be listed in many catalogs, and have a corresponding number of aliases; but this makes little trouble in practice, when we come to search for it or to identify it.

But we have not explained yet how the astronomer picks out the star he wants from among the many which are seen at once in the field of view of his telescope. Let us remember that the telescope is provided with a mounting, furnished with graduated circles, which tell him, always with the aid of the clock, toward what spot in the heavens it is pointing. He has only to look up this region on one of the Durchmusterung charts (or on a little tracing of the part of it where he knows he is working) and pick out some prominent configuration of stars—for example, a triangle, quadrilateral, or line of three—identify this in the telescopic field of view, and proceed to pick out the other neighboring stars and find the one he seeks. This covers the case of any star of the tenth magnitude or brighter, which can easily be seen with a three-inch telescope. For fainter ones, in the older days of observation there was no recourse but to make a sketch of the telescopic field with the star in question marked on it; or, if accuracy were important, to go through the laborious process of measuring the positions of the stars, one by one, with the micrometer.

Here, and indeed in all star charting and cataloging, photography is of very great service to the student of the stars. Any good telescope may be used as a camera, though yellow-sensitive plates must be used with an ordinary visual refractor. Such an instrument will give beautiful pictures of a region the size of the moon, or even twice as big. To photograph a large part of the sky at once we must have a special telescope—a sort of glorified camera—with a "doublet" objective, built on much the same lines as modern camera lenses of high quality but, of course, much larger. Such instruments will give sharp star-images over a field 10 or even 15 degrees in diameter, and tolerable ones over a whole constellation. The greatest lens of this sort is the Bruce Telescope—belonging to Harvard, and mounted at the southern station of the Harvard Observatory at Arequipa, Peru. This instrument has a diameter of 24 inches. A single photograph, with such a telescope, of a rich Milky Way region will show several hundred thousand stars, provided the exposure is long enough (three or four hours, at least); and the whole number of stars in the heavens accessible with such an instrument must run into the hundreds of millions.

Even fainter stars can be reached by long exposures with great reflectors, such as those at Mount Wilson; but with these the field of view is small, and it would hardly be practicable to cover the whole heavens, bit by bit. But if this should be done, probably a billion stars would be brought to light.

The positions of the star-images on such plates can be measured with extraordinary precision. Using as reference points the stars already observed and cataloged, as described above, the right ascensions and declinations of all the rest can be found with relatively little labor. A great international cooperative volume—the "Astrographic Catalog"—has been under way for many years, and is now more than half completed. It will give accurate positions of about two million stars. The plates used in the work were small, covering regions of the sky only two degrees square. Recent progress has made it possible to use much larger plates, and so greatly to reduce the labor and the cost. Indeed, Professor Schlesinger has shown that, by photography with a specially designed camera, it will be possible to prepare a catalog of all the stars in the whole heavens down to a little below the ninth magnitude—about 200,000 in all—for less than it costs to observe the similar stars in a zone five degrees wide with the meridian circle, and with greater accuracy than the circle gives. The Yale Observatory is undertaking, single-handed, this great piece of work—a fine example of scientific management.

The camera is even more valuable for charting the stars than for cataloging them; for it gives us, at once, the very map of the stars that we desire, without the laborious effort of working out our observations and plotting them. Several series of photographic charts have already been prepared. Most notable are the productions of an English amateur and of two continental professional astronomers. The former, Mr. Franklin Adams, working at his private observatory in England and also upon an expedition made at his own expense

(*Continued on page 142*)

When We Build Our House

Facts Regarding Kinds and Grades of Lumber Which Should Be Known By the Home Builder

By Samuel J. Record

Professor of Forest Products, Yale University

WHEN we say we are building a house we do not expect to be taken literally. We mean we are having a house built for us—a pretty good thing for the house that such is the case! If we furnish a few ideas we are willing to leave the rest to the architect, if it's that kind of a house, or more likely to the builder. We are likely to think only in terms of the finished structure, and outside of the cost, our chief concern is whether it will be hard to heat in winter, will the den come up to expectations, will the fireplace draw, is there enough closet space, and what will our neighbors and friends think about it.

It is a pretty good plan to leave the structural details to professionals, but the more we know about what is going into our house the more pleasure we can get out of the building operations and the more satisfaction out of the finished work. This is particularly the case if ours is a frame house, because the materials are assembled from the forests of a whole continent.

Assume we live in the East. A ride into the country reveals abundant woodlands and it might be supposed that from them comes everything we need for a house. There was a time, perhaps, when this was true; but today there are millions of acres from which all the valuable timber has long since been cut, leaving little but culls good only for firewood and possibly a few railway ties. Pay a visit to a lumber yard and ask the dealer to show you all of his stock cut within a radius of 50 miles. The big piles you see traveled from 300 to 3000 miles, and the wider the boards and the fewer their knots, the farther they came.

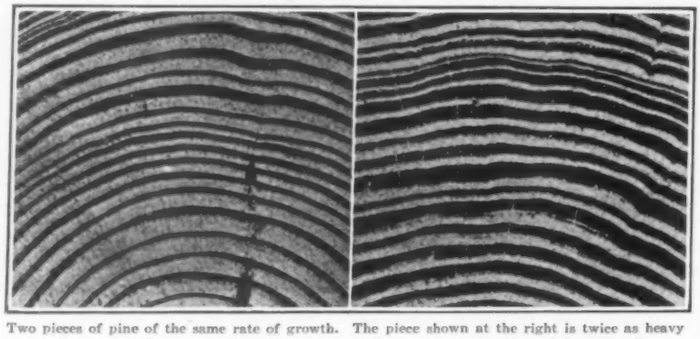
Perhaps you hadn't realized to what a great extent the structural timbers are cut from cone-bearing trees, the so-called softwoods, such as pine, fir, spruce, cedar, cypress and redwood. The broadleaf trees, the so-called hardwoods, such as oak, maple, birch and red gum, have their place, to be sure, but it is mostly for flooring and interior trim. The coniferous trees supply the finest structural timbers in the world because they combine the requisite strength and stiffness with comparatively light weight so much desired by builders.

Although it is possible to build an entire house from sills to shingles out of one kind of wood, this is rarely the practice except in cases where one kind of structural timber is particularly abundant. Some of the old homes in New England were built entirely of white pine, and their long service attests the good judgment of the builders; but in those days white pine was plentiful and cheap. Nowadays it is the usual thing for a dwelling to have from half a dozen to a dozen different kinds of timber in it. And the less expensive the structure the greater its wood complex is likely to be.

In the choice of structural timber the two principal features of concern are strength, including rigidity and durability. There is no such thing as fire-proof wood, advertisements to the contrary notwithstanding, though the inflammability of wood can be greatly reduced by the application of proper chemicals and paints. However, this has not become a common practice in this country. For detached structures, the fire hazard of a wooden building is not excessive and in any event it depends more on the contents and other factors than on the materials of construction.

As for durability, this is largely a question of resistance to decay, though in some places the destructive action of ants is very serious. In the first place it should be remembered that no wood will rot so long as it is kept thoroughly dry. The kind of wood has nothing to do with it in this case as you will readily appreciate if you stop to think of various wooden objects that will last for years and years when kept indoors. Exposed to moisture, however, the proposition is quite different and some woods will resist decay a long time and others will rot very quickly. All wooden members of a building that are subjected to dampness should be chosen with care. The heartwood of cypress, redwood, and the various cedars are all resistant to decay, while with pine the most durable timbers are those heavy with resin. In choosing for decay-resistance there are two excellent guides, dark color and fragrant scent. Dark-colored woods are usually durable whether they are fragantly scented or not, and fragrantly scented woods are durable without regard to their color, as witness Port Orford cedar, which is yellow, and northern white cedar, which is light brown. These scented woods are usually highly resistant to insects also. Logs from which lumber is cut have an outer portion, called the sapwood, which is always light-colored, and this wood is not resistant to decay or insects no matter what kind it may be.

As just stated, wood does not decay if kept dry. The so-called dry rot is no exception to this rule. The fungus producing this rot has the ability of absorbing moisture from humid and stagnant air and consequently can thrive where other wood-destroying fungi cannot live. It is one of the deadliest enemies of wooden structures, but there are two ways of defeating it; first, to use only durable timber in places where the humidity is high; secondly, to provide proper ventilation for such places so that the air cannot become stagnant. Where a heated basement extends under the whole house the danger is not very great, but one should look out for damp cellars, porches and portions of buildings near the ground. Painting timbers in such places may help and it may make matters worse by keeping the interior of the wood moist and all the better suited for the wood destroyer's activities.

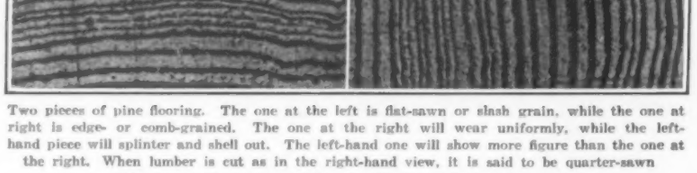


Two pieces of pine of the same rate of growth. The piece shown at the right is twice as heavy and strong as the one on the left, because of the greater proportion of dense wood

The tell-tale growth rings of pine

Examining the various kinds of lumber intended for the framework, it will be noted that there is considerable difference in its quality and freedom from knots and other defects. Lumber is graded chiefly according to its defects, the number, size and location of knots, pitch pockets, worm holes and the like, and is priced accordingly. It is consequently to the financial advantage of the builder to use the lower grades in places where they will serve the purpose well, as, for instance, in sheathing and underflooring.

It very often happens that light-colored lumber gets rather badly stained at the mill before it can be dried. Some mill operators avoid this by running the boards through a hot soda bath on their way from the saw to the lumber pile, but others take a chance and if the weather is real muggy the lumber turns blue in spots. This lowers its grade and its selling price, but otherwise has little effect on the wood. For certain purposes stained stock is just as good as any, and the use of it may mean a decided saving. Brown stains are likely to indicate rot. One can usually test this by digging into a suspected place with the point of a knife. If the wood is soft and punky it is well to leave it alone.

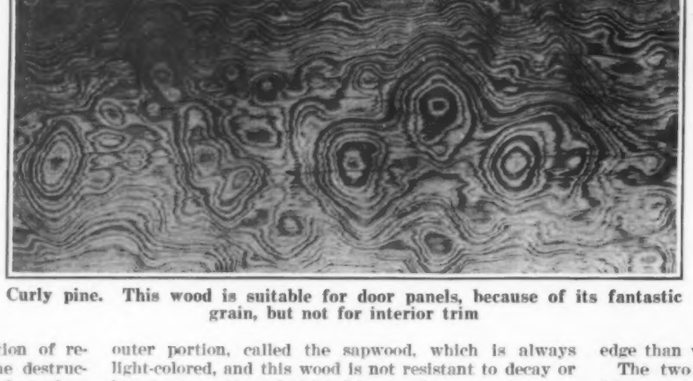


Two pieces of pine flooring. The one at the left is flat-sawn or slash grain, while the one at right is edge- or comb-grained. The one at the right will wear uniformly, while the left-hand piece will splinter and shell out. The left-hand one will show more figure than the one at the right. When lumber is cut as in the right-hand view, it is said to be quarter-sawn

How to tell whether flooring will wear well or not

The question is often asked as to what effect knots have on the strength of timber. It would require a whole book to answer this because it all depends. A knot is a portion of a branch with its fibers running at an angle to the stick it is in. A sound knot is harder than the rest of the wood. Knots have least effect in sills which are supported throughout their length, secondly, in upright pieces such as posts and studding, and are most serious in pieces subject to bending as in beams. The under side of a beam is stretched in bending, the upper part shortened or compressed, and the middle is neither one nor the other—it is neutral, in short. Consequently, a knot is most serious on the under side than on top, because it is easier to pull one in two than to crush it. The damage is least of all in the middle and near the ends. Beams of considerable size are likely to show as many knots on one face as on another, but wherever there is a decided difference the smallest knots should be on the bottom. One large knot is worse than many small ones. Floor joists are narrow beams with a long span, and more care is necessary in regard to knots and other defects than in the case of broader beams with less distance between the supports. Floor joists are planks set on edge and are so designed in order to get the greatest stiffness with the least weight. A timber 12 inches wide and 2 inches thick is 36 times stiffer when laid on edge than when laid flat.

The two principal woods used for the beams and joists are southern pine and Douglas fir. Southern pine has been the standard structural timber of the eastern half of the United States for a great many years. Many



Curly pine. This wood is suitable for door panels, because of its fantastic grain, but not for interior trim

tropical countries, to which we are looking for possible future supplies of lumber, are heavy buyers of pine because it is easier to get and to use than their own woods. The heaviest and strongest of the southern pine timber is the longleaf or Georgia pine. Nothing surpasses it for heavy construction. It is a timber that is highly resinous and therefore very durable. It makes excellent flooring when properly sawn. Much of the pine used in dwellings in the East is the so-called North Carolina pine or loblolly. It is coarser grained than longleaf and often has an overabundant supply of knots, but it is comparatively inexpensive and serves many purposes very well indeed. Short-leaf pine is intermediate, usually being lighter and softer than longleaf and usually not as defective as North Carolina. Arkansas soft yellow pine is part shortleaf and part loblolly, and makes better interior trim than longleaf because it contains less resin or pitch.

During the past few years Douglas fir from the giant forests of Washington and Oregon has been entering the eastern market in ever-increasing quantity. At first there was considerable prejudice against this timber, but this is being rapidly overcome as experience shows that the wood can be employed successfully for virtually all the purposes of southern pine. It has one advantage over pine in that it is to be had in larger sizes free of defects. So far as the home builder is concerned he need have no hesitation in using Douglas fir. It has been used throughout the West and in many foreign countries for a great many years. In the export trade it is known as Oregon pine. Fir is becoming very popular for siding.

If you are looking for strong wood remember that strength and weight or density go together. Of course this applies to sound dry wood, for any wood is heavy when it is wet. With the coniferous woods it is easy to judge density and therefore strength from the rings of growth as seen on the end of a stock. The white layers are soft and weak while dark ones are hard and strong, hence the greater the proportion of dark layers to the rest of the wood the heavier and stronger it will be found. Grading rules have been devised for southern pine and Douglas fir which take this fact into account, so that the builder who desires very strong material can be sure of getting it.

Various woods are used for studding. From the northern New England forests come spruce and balsam fir, both sold as northern spruce, and also hemlock. The war attracted attention to the Sitka spruce of the Northwest and now regular shipments of this timber are usurping the spruce market in the East and some of it is very coarse and brash. Eastern or northern spruce is usually white in color and has small, often black knots, but western spruce is pinkish or brownish and has coarse red knots. For certain purposes spruce is very useful, but it is not in the same class with longleaf pine and Douglas fir.

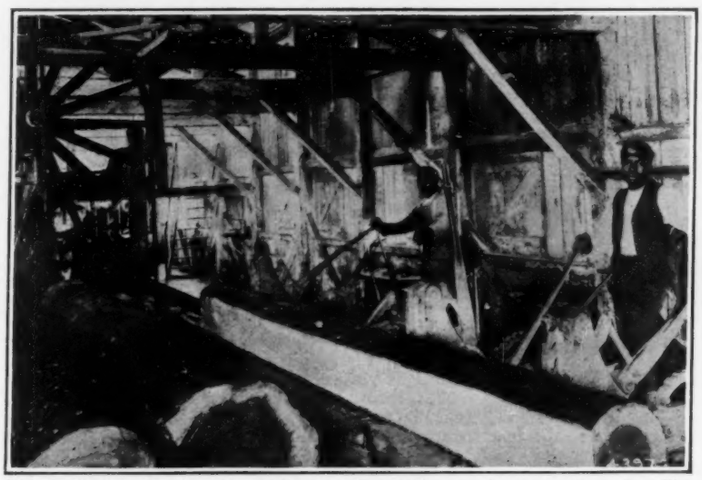
Many different kinds of wood are used for shingles though the bulk of the shingles in the trade are of western red cedar from the Pacific Northwest. They are of a brown or pinkish-brown color and in the better grades are straight-grained and free of knots. A few shipments of Port Orford cedar from the same general region have been made to New York. This is a yellow cedar with a very pungent odor. Cypress and redwood make good shingles and are much used locally. It is usually poor economy to use poor shingles, and the thicker grades are less likely to warp and split than the thin ones. Very often shingle roofs fail because the nails rust off, rather than due to the decay or weathering of the wood. Shingles are kiln dried to reduce their weight, but they should be exposed to the weather or given a wetting before use.

When it comes to flooring the two standard woods are southern pine and white oak. Both are at their best when quarter-sawn, that is, cut across the rings of growth rather than along them. In pine, such flooring is known as edge-grain, or sometimes as comb-grain, as opposed to flat sawn or slash grain. Looking at the end of a pine board you will see that there are alternate light and dark layers. The dark layers are much the heaviest and hardest and if these are put edge up the wear will be uniform while the flatsawn boards will soon begin to splinter. Douglas fir also makes a good flooring and trial shipments of western hemlock are now coming into the eastern market. Western hemlock has long suffered from the reputation of its eastern relative of that name, but is now beginning to be appreciated. Maple, birch and beech make serviceable floors, but they cannot be considered in the class with white oak, the premier of all flooring woods. Good flooring is kiln-dried at the factory and shipped in sealed cars. It should never be exposed to the weather.

As for interior finish the home builder has a wide range of choice and he should proceed with care and choose something easy to live with. He should carefully avoid highly figured and curly grained woods except for small panels. Of the conifers, the most commonly used are southern pine and cypress in the East, and Douglas fir, redwood and pine in the West. The principal hardwoods are oak, ash, chestnut, red gum, birch and walnut. Red gum, often called hazel, formerly had a bad reputation for warping, but modern methods of drying the lumber and putting it in place have largely overcome this drawback. For painted woodwork, the important thing is to get a wood of fine and uniform texture free of resin and gum. In this class are birch, soft maple, whitewood or poplar, white pine, sugar pine, certain grades of southern pine, and various others. The sugar pine is California's contribution to make good, in part, the depleted white pine forests of the East and North. The wood is somewhat coarser textured and has some rather conspicuous dark resin-duct lines; still, it is a splendid wood for service wherever a light, soft, uniform material is needed. It is quite likely that the material of the sash, doors and blinds of our house was California grown.

Knowing its several components our house acquires an added interest. The forests of the north supply spruce, fir, hemlock and birch; those of the south, yellow pine, cypress and red gum; from the interior hardwood region come oak, maple, yellow poplar, ash and walnut; while from the Pacific coast we get Douglas fir, redwood, sugar pine, western white pine and cedar. Some of the fir and spruce and cedar may be of Canadian origin and part of the southern pine may have originated in Mexico or Central America, for we are fast outgrowing our virgin forests and looking for new fields to conquer.

This all adds to the interest of the home builder if he will familiarize himself with these timbers and their source. Incidentally, if he thinks of the long haul and the freight bill he will begin to understand why lumber is not as cheap as it used to be and perhaps begin to wonder if it wouldn't be a good proposition all round if Nature's local tree-producing energies were directed toward the production of lumber instead of being wasted on scrub oaks and other woodland weeds.



The clear lumber comes from the outside of the logs, as there are knots near the center. The white bands on the ends of the logs are the sapwood, encircling the darker and more durable heartwood

Sawing southern yellow pine logs into building material

This room is finished throughout in red gum, often called hazel. The figured gum resembles Circassian walnut in coloring and mottle; indeed, it is coming into use in moderate priced furniture because of its beautiful appearance.

Taking full advantage of the grain of red gum

The Extermination of Insects

IN the *Scientific Monthly* for July, 1922, Dr. E. P. Felt, State Entomologist of New York, discusses various methods of exterminating insects, and especially the method of so reducing the members of a pest that natural agents or hazards actually bring about extermination. Dr. Felt is of the opinion that the method of progressive reduction, if one may use a special term, has not received the consideration it deserves, and yet it has been the method which has brought about extermination of Gipsy Moth colonies in areas well removed from the generally infested territory.

It is interesting in this connection to review the work of the earlier days against the Gipsy Moth when a systematic and very costly effort was made to find every egg mass in woodlands as well as on improved grounds and destroy them by hand, trees being climbed and walls taken down and relaid in the search for the last egg mass. This was supplemented by spraying the foliage in the infested area and banding the trees for caterpillars. Later developments have shown that much of this laborious egg hunting can be eliminated by a system of spraying and cutting out low bushes or favored food plants. Conditions are thus changed to such an extent that the insect is unable to maintain itself and eventually disappears.

Apparently, because insects are small and under certain conditions exceedingly abundant, we have failed to make allowance for the results following a great reduction in the number of individuals, especially if this be continued year after year. The matter is of more than passing importance, because there is a possibility of making practical application of the principles involved and obtaining at a relatively moderate cost results which might eventuate in large savings by eradicating injurious species before they had an opportunity of establishing themselves over extended areas.

If we turn from the field of entomology to the broader realm of zoology, and consider what has occurred in the case of larger forms, we may find some very suggestive hints.

One of the most striking instances of this kind is the extermination of the passenger pigeon, a bird at one time so extremely abundant that three carloads a day were shipped from one small Michigan town for a period of 40 days.

The systematic destruction of prairie dogs has resulted in over 4,000,000 acres of public lands being "largely freed" from these pests. There has also been very effective work against pocket gophers and rabbits. It is within possibilities to make local and almost complete eradication absolute.

In view of the above, Dr. Felt believes that the problem of insect extermination should receive most careful consideration and as opportunity offers, tests or demonstrations should be undertaken.

When Will Automobiles Be Perfect?

DESPITE the momentous and rapid development of the motor car industry during the last two decades to the point where now it is one of the leading occupations of the country, the best is yet to come according to the opinions of eminent automotive engineers. Many laymen believe that the automobile of the present is as nearly perfect as it is humanly possible to make a mechanical vehicle. Car manufacturers and inventors, however, appreciate that many practical and essential improvements must yet be made in the horseless carriages before they attain the stage of mechanical perfection. The cars of the present abound in gloss and glitter, graceful lines, splendid bodies and powerful engines; but they lack in internal efficiency and the ability to convert gasoline into power with the minimum waste of fuel.

It is not beyond reason to predict that the future of the motor car industry will depend largely on the development of more economical systems of utilizing fuel. Though for the present gas is cheap compared with the 1920 peak, the future supply is hazardous. Gas waste and the extravagant use of fuel must accordingly not be countenanced. Furthermore, we must impress upon car makers and designers the importance of adapting car construction to portending fuel shortages. The quality of gasoline as well as its volatility constantly are becoming worse. This means that engines designed to use the best grades of fuel are inefficient because the gasoline is of bad quality. Refiners gradually are allowing the quality of the fuel to depreciate in their futile attempts to make the available supply satisfy the heavy demand. There is not much chance that the refineries will improve the volatility of the gasoline so about all that the motorists can do is to increase the average mileage which they now get out of one gallon of gasoline.

One of the most practical methods of increasing the mileage is by providing some efficient and satisfactory method on all cars for heating the intake manifold. Simply heating the air by passing it over the exhaust pipe before it enters the carburetor is not sufficient. It is fundamentally essential that the intake-manifold design be changed in all cars which have not already attempted to correct this defect so as to curtail losses from cold manifolds. Gas is wasted in large amounts in starting cold cars as well as in accelerating cold engines. The intake manifold is continually exposed to temperature changes even during ordinary running where the drivers have to slow up for traffic or at corners or else speed up for grades or in passing other cars. Any mechanical appliance which could be adjusted on the manifold so as to keep it hot and at an even temperature would satisfy a vital, existent need.

It is also essential that crank-case dilution be eliminated in our present models of automobile engines if the best potential results are to obtain. Not one-tenth of one per cent of the motor cars now in operation completely vaporize the gas in the cylinders, and as a result some of the raw gasoline runs down into the crank case with the lubricating oil where its fuel value is wasted and trouble develops in the crank case and bearings as a consequence of the presence of this foreign material. Engine friction is as serious a source of power loss as crank-case dilution. The tendency among manufacturers has been to place, in the cars used for general motoring, small engines which must be run at high speeds—the same as those used in racing cars. The fact is, such general utility cars should be equipped with large engines running at low speeds. Engineers of the Bureau of Standards recently conducted some interesting tests to determine the importance of engine friction. They found that it required a force of 70 pounds to tow a large touring car behind another car over a macadam highway at a speed of 10 miles an hour when the gear was in neutral. The motive force had to be increased to 110 pounds to tow the car in high gear and to 220 pounds to move it when the gears were set for second speed. In this case the engine friction amounted to 150 pounds, being the difference between the power necessary to move the car when in second gear and in neutral.

Another needed improvement is the provision of a carburetor which may be simply adjusted from the driver's seat so as to insure the most effective utilization of the fuel. Unquestionably, future types of motor cars will be provided with simple carburetor-throttling devices which may be attached conveniently to the steering wheel where the driver can adjust them as the car is in motion without undue trouble. If a contrivance of this type could be devised which might consist of a sliding lever which could be moved in one direction to increase the power and richen the mixture, and in the other direction for a lean mixture and a more economical use of the fuel, existent extravagances in the use of gasoline on cars which are equipped with non-adjustable carburetors would be eliminated.

The simple rule used by the Bureau of Standards for determining what adjustment of the carburetor is proper and most satisfactory is to employ the leanest mixture which will fire regularly during a long drive. This goal is reached by leaning down the mixture until it begins to backfire through the carburetor. Henceforward as exigency for so doing arises, the mixture may be richened and the power increased for hills. Owners who drive their car 10,000 to 15,000 miles a year or more will find that they can greatly reduce their annual gas bills if they will adhere to this plan. Maximum economy and maximum power do not occur at the same point in automobile operation. Government tests have shown that maximum power obtains where the mixture consists of a blend of 13.5 pounds of air per pound of fuel while maximum economy results from a ratio of 16.5 to 1.

It is not anticipated that any decided improvements in engine-oiling systems will be effected in the near future; consensus of opinion is that they are already about as highly developed as they ever will be. Greater effectiveness in the use of lubricating oil could be gained if only refineries would produce oils of similar grade and quality, year after year, instead of allowing the different types of oil to deteriorate in quality as they do. In the operation of motor cars, it is important to maintain the combustion chambers free of oil pollution. Oil enters the combustion chamber when it is pumped into the main bearings to an extent where it overlubricates the cylinder walls. This can be prevented by the use of oil-scraping rings. Opportunity for the oil eliminated from the walls to flow from the combustion chamber should be provided in the form of adequate openings.

All cars of the future should be furnished with automatically lubricated spring shackles as such equipment increases the service period of the car, improves the ease of riding and lessens the worries of the driver.

The Chemical Go-Between

A HAS a house that he would like to sell or let and B is desirous of buying or renting one. A and B must come together before the transaction can be closed. A may try to find B by himself, and it may be that he will so find him in the course of time. But A may be in a hurry and want the matter over right away. So he goes to a broker who brings him in contact with B quickly and closes the deal. The broker is the accelerator of the action, which would take place anyway, but only very slowly.

A chemical process depends upon two or more substances reacting with each other to give the desired product with, perhaps, a by-product as well. For example, if we want to make soap we heat fat with a solution of lye, and we get not only soap but glycerine as well. Now, every chemical change or process has a definite time that is required for its completion under certain determined conditions. The chemical go-between or the chemical "broker" is a substance which increases the speed of the action with the result that the product is formed in much less time with accompanying increased capacity of plant and reduction in cost.

The story is told of an alchemist, a chemical magician, who described a fanciful method of obtaining gold by starting with a bit of "medicine" the size of a bean. Throwing this on mercury he took an ounce of the red powder produced, and threw it again on a thousand ounces of mercury, and so on until the latter changed into gold. The idea of something in a very small quantity causing by its mere presence a profound change to take place, which would otherwise be effected slowly or else not at all, seems just as preposterous as the idea of the final result being gold. But that is just what the chemical "broker" does. This is the substance which the chemist calls by the odd name of "catalyst," and the action itself "catalysis."

There are two peculiar properties of all catalysts, namely, the fact that only a minute quantity is required to effect their action and secondly that they themselves suffer no change during the process, but at the end of the same are in the same condition as at the beginning. They do, however, become "used out" (which is entirely different from "used up"), and must then be regenerated, literally made healthy again, before they are once more potent to do their work.

Probably the most interesting of the catalysts are the substances known as enzymes, for they carry out their action in our own bodies in the digestion of the food we eat. Digestion is a chemical process, whereby the food is changed into a form that can be absorbed by the fluids of the body and converted into heat and muscular energy. The process starts when we chew our food and masticate it thoroughly with the saliva. The enzyme of the saliva, pytalin, changes starch into sugar. Pepsin in the stomach decomposes meat and other albuminous food, such as eggs, into soluble form. All these substances are present in the fluids in small amounts and bring about the change in short order. There is a commercial enzyme made from yeast which can change 200,000 times its weight of sugar into glucose. One part of rennet will convert 400,000 parts of skimmed milk into cheese.

Perhaps the extreme of catalytic action is illustrated with the familiar antiseptic, peroxide of hydrogen. This substance is unstable, that is, it tends to break up easily into the materials from which it is made, namely, water and oxygen. In fact, it is this very instability which makes it such a good antiseptic, for the oxygen produced destroys the cause of the infection. This decomposition is accelerated so fast by a drop of a solution of platinum, that one part of the latter will cause the decomposition of 300 millions parts of peroxide.

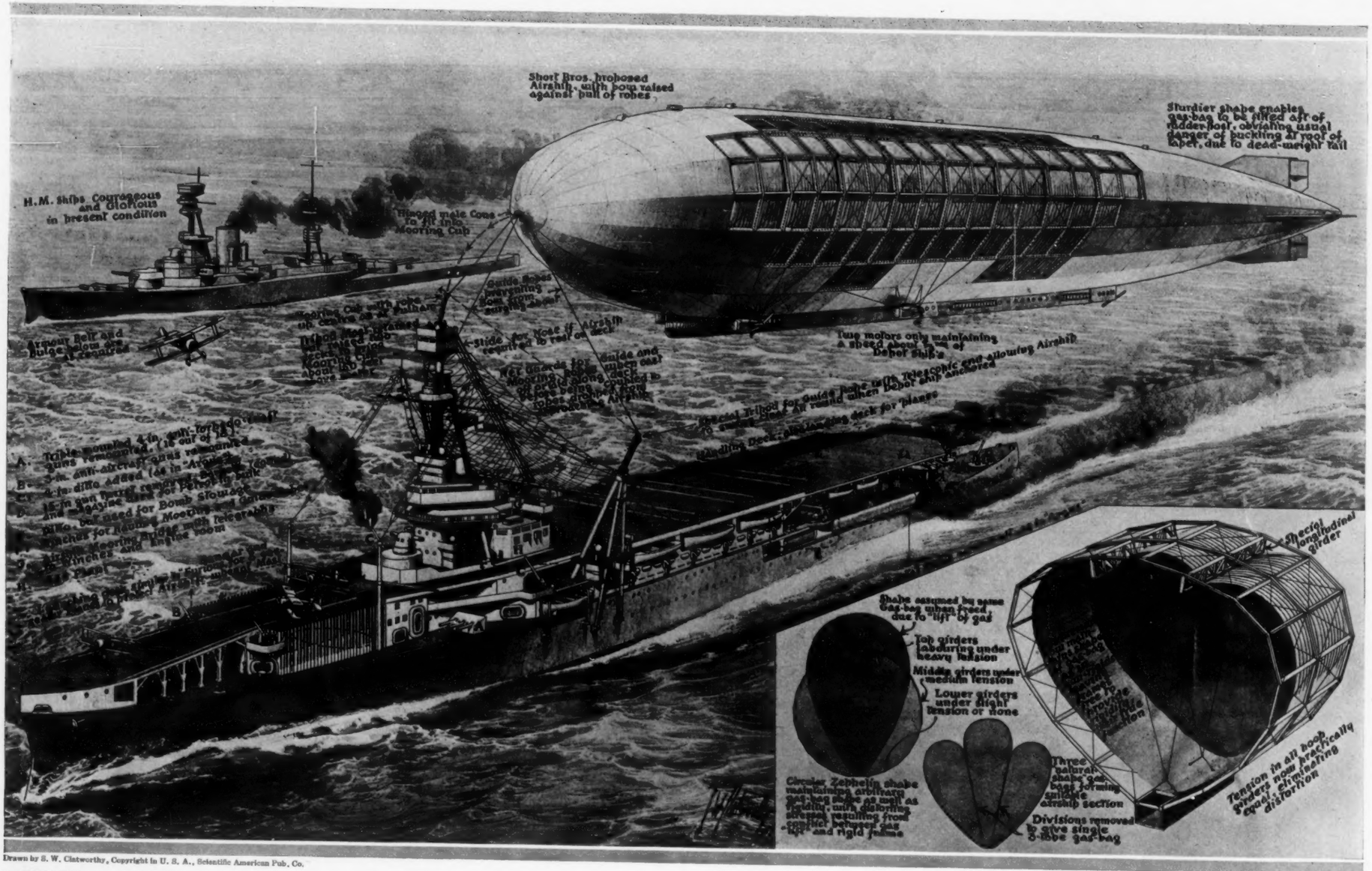
The commercial importance of catalytic agents is very vital to many industries. Sulfuric acid, the king of chemicals, so-called because of its almost universal use in chemical and allied industries, was made formerly in such a way that an acid containing a great proportion of water was obtained first. Then, as a strong acid had to be had for various purposes, the water was evaporated to concentrate the acid. For the manufacture of indigo a very strong acid is required and the difficulty of getting this from the weak acid, produced at the start, led to chemical experimentation, until it was found, after much time and the expenditure of much money, that by the aid of platinum and other materials, which act as catalysts, the 100 per cent acid could be made directly from the sulfur, and then if a weak acid was required, all that was necessary was to add the proper quantity of water to the strong acid. Today a great deal of the sulfuric acid made in this country and abroad is manufactured by this so-called "contact" process and subsequently diluted to the desired strength.

Not long ago we read of the blowing up of the Oppau plant in Germany, which was making ammonia fertilizer in large amounts. This process depends on the use of catalysts and so does the process of making nitric acid from the air, which was the sole reason why Germany endured so long in the war after its supplies of Chile nitrate of soda were cut off. You cannot make explosives without nitric acid.

The cotton that comes from the cotton plant contains seeds. Until Whitney invented the cotton gin, it was a very tedious operation to pick the seeds out by hand, for that had to be done before the cotton could be spun into thread. For a long time thereafter, the cotton seeds were thrown away, for there was no apparent use for them and in truth they were a serious impediment around the plant. Then, someone found that it was possible to extract from them an oil, which was edible and very useful in cooking and for making salads. The seeds were no longer thrown away, and an entire new industry was developed and the cotton-seed-oil by-product became almost as valuable as the cotton itself. But the oil was not convenient to handle while frying, and people did not take kindly to it. Then, it was found that when hydrogen gas was passed through the oil in the presence of finely powdered nickel and other metals, the gas was absorbed by the oil and the latter was converted into a solid fat, just like lard. Only a small quantity of nickel was required for this purpose. Nickel is the catalyst in the process.

There are numerous other processes in which catalysts are used. Indigo dyes are made with the aid of catalysts. Photographic prints are made without sunlight by their means. Alcohol can be changed into formaldehyde by them. The solvent, cleansing agent and fire-extinguisher, carbon tetrachloride, is manufactured with the aid of the catalyst iodine and in fact there is hardly a chemical manufacturing process of importance that does not at some stage employ the services of a catalyst.

PROPOSED TYPE OF RIGID AIRSHIP SUITABLE FOR COMMERCIAL OR WAR-TIME SERVICE, AND A DEPOT SHIP WITH MOORING MAST, EVOLVED FROM A WAR-TIME CRUISER



Drawn by S. W. Clatworthy, Copyright in U. S. A., Scientific American Pub. Co.

BRITAIN'S recent decision to retain airships gives rise to speculation as to possible improvements in design. The new design shown in the accompanying drawing promises to place the structure of rigid airships, for the first time, upon a fundamentally sound basis. It is proposed by Messrs. Short Brothers, who built the successful wooden rigids "R-31" and "R-32" and who commenced but did not complete the ill-fated "ZR-2."

Following the Zeppelin type, all rigids have previously had an approximately circular section, and the conflict in stresses between this arbitrary shape and the gas lift has probably caused, at critical moments during navigation, several past disasters. A cylindrical ballonette, floating free, will assume a shape similar to that of an inverted drop of liquid—as in the lower left-hand corner of the smaller drawing—and when confined in a circular frame, exerts very little outward pressure in the lower half and a maximum at the top. As a result, tension in the lower girders, wires, and fabric is practically non-existent, while in the highest it is at a maximum. The framework is therefore perpetually tortured, so to speak, by this disruptive inequality, against which partial protection only can be provided in the shape of wastefully heavy and needlessly complicated radial wiring.

Now, in non-rigid airships, many of which have proved to be excellent designs, the gasbag is largely untrammeled, and this feature is incorporated in the Short ship by "natural shape" ballonettes. A single inverted-drop section would not be practical for several obvious reasons. This object is achieved by combining three such, removing the two partitions and substituting lift wires as in the lower diagram. The tendency of the gasbags in existing ships to force up the top longitudinals, noted by Mr. Oldroyd in his capable analysis in our July, 1922, issue, is obviated here by two special girders of wholesome depth, to which the lift wires are attached. The tension throughout each hoop girder is now practically constant.

Numerous circumferential wires, as shown, take the lift of the gas in the first instance, and are anchored only at their lower ends. From the circular ship, therefore, imprisoning protesting gas containers to the detriment of the structure, we get the new ship with a lightened basket of girdering snugly fitted round quiescent gasbags, and free to fulfil its true function of rigidity.

To point the moral, the "ZR-2" actually had additional new girders from the keel to the sides, forming a chord in each lower quarter-hoop, distinctly suggestive of this new shape if the outer, original girders are removed. The ship shown is a proposed London-New York passenger liner, 4,450,000 cubic feet, to carry 50 passengers at 60 knots for 6000 nautical miles. Her shape resembles that of the usual double-hulled submarine which is buoyant, of course, submerged in water just as the airship is submerged in the atmosphere. The airship is shown towed from the mooring mast of a converted "Hush-hush" ship.

PROPOSED TYPE OF RIGID AIRSHIP SUITABLE FOR COMMERCIAL OR WAR-TIME SERVICE, AND A DEPOT SHIP WITH MOORING MAST, EVOLVED FROM A WAR-TIME CRUISER

Our Psychic Investigation

The "Direct Message," and the Relation Which It May Ultimately Have to Our Work

By J. Malcolm Bird

AMONG the psychic phenomena of spiritism that have occurred over and over, until they have come to be a commonplace of spiritism just as a telegram is a commonplace of business, first rank is held by the direct spirit message. The medium with her own hand, or her own voice, or her own vocal mechanism speaking in a voice not apparently hers, delivers a written or a spoken communication. This purports to come from some deceased person who is present in his own identity, and to be addressed to one of the sitters. Usually the alleged communicant is a friend or relative of the recipient; but in many cases he is merely an identified or unidentified spirit who seizes the opportunity to communicate with our world.

To one witnessing this for the first time, of course, the conditions and the technique are not in the least impressive. The suggestion of fraud is so strong as to amount, in the absence of emotional reactions, to practical certainty. If I seize my pen and write a message and sign it Alexander the Great, why should you believe that I have not composed and written it myself? If, in the bargain, the alleged message is of a wholly trivial character, having no relation to the identity of the communicant or of the sitter; if it be entirely appropriate as a message from any dead person whatever to any living one—the suggestion of conscious and deliberate fraud on the part of the medium is just so much the stronger.

Now in a very considerable proportion of the cases that occur the message is of just this character. "My darling—I am so happy to communicate with you—I am well and happy and watching over you—I see you every day and know all you do—it is very hard to communicate with you—what joy it gives me to overcome the obstacles—I must go, but I shall come again." Such a message may be genuine but there is no internal evidence to show its genuineness; and many of the messages about which the recipients get so wrought up are of precisely this character. There is no profit for anybody concerned in ignoring these facts.

Equally, however, there is no profit for the skeptic in ignoring certain other facts that are not so easily built into his structure of unbelief. In spite of the unimpressive technique involved in the use of the medium's hand and mouth, there can be no rational doubt that many mediums are genuine to the extent that the speaking and writing are done without their volition or even without their consciousness. Nor can there be any doubt that there exists a great bulk of "evidential" messages, which are by no means trivial or lacking in pertinence to the recipient and to the alleged communicant. Such messages are full of direct and indirect references to the relations existing between communicant and recipient during the former's life. The wealth of detail and of specific incident is often staggering. One might as well try to deny Niagara or radio broadcasting as deny this. The thing occurs. What are we to do in the way of explaining it?

Just two explanations have been offered that meet the facts. One is the hypothesis of individual survival of death, followed by communication. The other is the hypothesis that there exists a faculty of communication between the minds of living persons, outside the usual channels of sense perception.

Either theory, in order to account for all the facts, must be considerably elaborated. The one requires a number of assumptions regarding the conditions of survival and of communication; the other demands equal liberality in assigning to the living mind powers and properties which it is not demonstrated to possess.

If the known facts verify one hypothesis and eliminate the other, that is the end of it. If they do not, we seek further facts that shall settle the matter. Pending the discovery of these we are not permitted to give either hypothesis precedence over the other. But any concrete postulate is necessarily either pleasing to you, and to me; or else distasteful. Pending the final determination, we are at liberty to admit this and to express a provisional preference for the one alternative or for the other.

The present writer has already (May, 1922) indicated his preference in this way. Everybody else enjoys equally the privilege of having his own preference. The unhappy fact is, indeed, that both explanations explain so completely and in such detail that it seems to be an utter impossibility to discriminate between them by piling up a multitude of observations upon mere direct messages. So far as I can see, no message susceptible of verification could ever be received which could not with equal completeness be accounted for on both grounds. It therefore seems necessary, if we are ever to discriminate between the theories of survival and of telepathy, to turn our attention into some channel other than that of direct messages.

We make this detailed explanation because a very large number of correspondents have written in specific or implied criticism of our action in ruling out from our present investigation the direct message. It seems to be generally assumed that we do this because we regard such messages as unimportant and unworthy of investigation. This is exactly opposed to our real attitude. But we *do* consider that in the present state of knowledge the direct message has yielded all that it can to investigation, and that further progress in collateral fields is necessary before anything more can be said about these messages. If we can find something else that can be explained by postulating the action of departed intelligence, but not by telepathy, we shall have made progress. If we can find some other possible field of activity for these intelligences in which the question can be more directly verified whether it is they or some other agent at work; if we can find some other avenue of proving that they do or do not exist—then we shall have done something throwing real light upon the direct message. If, on the other hand, we can demonstrate clearly that telepathy is or is not a subconscious faculty of every human, that it is or is not a long-range phenomenon, that it is or is not selective as regards the source and character of its data, etc., etc., we shall have made a similar contribution.

It is really of the most vital importance to determine the character of these messages. If they are telepathic, we certainly want to isolate and develop the faculty so that we may all enjoy it. If they are from another world that exercises a directing influence over our lives, we certainly want to isolate and utilize that influence to its fullest capacity. By restricting our activity to the things which there is good ground for hoping that it may be possible to settle at the present time, our energy will be best applied. It is only fair to say that all of the judges do not agree in all details with all that I have said.

Just by way of demonstrating our open-mindedness, we recite the contents of correspondence which we have had with a gentleman whom, in the absence of specific permission to print his name, we shall call Dr. X. Mrs. X. was stricken with what was plainly a mortal illness; and a compact was made that, after her decease, if she preserved her identity and found communication possible, she should try to communicate. A countersign was agreed upon and stored away in safe deposit under proper seal; this countersign was to be used by her in any genuine message. After her death, Dr. X. sought communication from her through numerous mediums. He got alleged communication, from numerous mediums, but never the password. He finally offered $500 for the countersign; and he still has his money. He has had direct sittings with a large number of mediums, and has had mail communications, more or less spontaneously, from a large number more. He has received 109 different alleged countersigns, none of them correct, and none duplicated with the single exception of the very obvious word "Mizpah."

Dr. X. feels about telepathy more or less as we do, and he would be just about as well pleased to get the correct countersign in one way as in another. He has accordingly made no effort to exclude telepathy from his sittings. He has, on the contrary, sat in the presence of mediums and concentrated with all his mental energy upon the true password; but to no effect. The production of 109 incorrect countersigns under such conditions can mean but one thing as regards the mediums; a very great number of persons are masquerading as mediums who lack proper capacity for producing, by whatever means they are ordinarily produced, genuine "direct messages." We can forgive a medium for failure to produce any results, for the conditions governing mediumistic procedure are not clearly known and there seems every reason for believing that they are erratic and delicate. We could even forgive a few mediums for getting the wrong message from the wrong spirit or from the wrong telepathic source. But 109 consecutive specific performances that are wrong impress us very unfavorably. It looks altogether too much like an out-and-out guessing contest.

At the same time, the failure of any of Dr. X's mediums to produce his countersign telepathically is rather a blow to the adherents of that theory. We think that the occurrence of telepathy is too strongly substantiated to be denied in toto. But certainly explanation is demanded to account for the failure of 109 persons who may, as a class, be assumed much more sensitive in this direction than the average person, to deliver the goods to Dr. X. Is the doctor a non-conductor of extraordinarily high resistance? Or what *is* the matter?

As offset to this, we relate the case of Captain J., of the United States military establishment. The Captain puts it before us, with full permission to investigate; and as it falls within our field of physical phenomena, we hope to find it possible to do this. In his father's house there began, several years ago, what is described as a popping noise, like the snapping of fingers. It comes once, twice or thrice in rapid succession. It began in one room and gradually spread to the entire house. Sometimes it misses a period up to two weeks, but as a rule it pops every day. When in action it is heard from 25 to 50 times a day. The family visited another son in New York, and the popping preceded them, announcing their impending arrival by a margin of several minutes. It stayed in the New York apartment throughout their stay and for a month afterwards; whether it occurred during this time at the old homestead we have yet to learn. It has been heard by a very large number of people.

Of course there are alternatives to a real live ghost as the explanation. It might actually be a hallucination on a large scale; we are not informed whether the attempt has been made to record it photographically. More probably, it might be a discharge of nervous or electrical energy at high "potential" from the anatomy of one or more members of the family; though this explanation might very well fail under careful examination of the conditions of its production, and especially of its persistence in New York. This persistence makes it seem unlikely that it is a phenomenon of one person, at any event.

WRITING at a time when our January issue, with its full statement of our conditions, has not yet appeared on the newsstands or in the mail-boxes of our subscribers, it is obviously out of the question for us to announce any definite entry from any particular medium. We have had serious inquiries from a number of apparently qualified mediums, however, and there appears to be no doubt that the Committee will have work to do from the start. It must be remembered, however, that the Committee itself cannot start too early. It must be organized, its procedure laid down, its dates arranged after much correspondence with the Committeemen and the mediums. It must be learned what phenomena each medium is likely to produce, and it must be decided what instruments are to be employed and in what way. In order not to hold mediums from out of the city in New York for an unreasonable time, all this must be done by mail. In short, we cannot decide today to make an investigation of this character, form our Committee tomorrow, and start seances next week. Just as soon as it is possible to make an announcement covering specific seances we shall do so; until it becomes possible, we must ask our readers to realize all the things that have to be done first.
—THE EDITOR.

The New Home of the National Academy of Sciences

By V. M. Whiting

THERE is being constructed, in Washington, a building that will be of interest not only to scientists all over the world, but to the general public as well. This is the home of the National Academy of Sciences and the hard-working National Research Council.

Facing the new Lincoln Memorial and occupying the whole block on B Street, between 20th and 21st Streets, it will be of almost equal classic beauty and a fitting companion to that structure. It was designed by Bertram G. Goodhue and is to be a large, low building of white marble in classic style of architecture, and will be decorated in symbols that will depict the progress of science as well as its benefit to humanity. One of the decorations will be a bronze bas-relief procession of the leaders in the different branches of science since the earliest Greek philosophers to our modern scientists.

In the center of the building will be a rotunda, and surrounding it seven rooms, which will constitute a sort of progressive museum, for in these rooms and the rotunda, will be displayed by the Council all the latest developments in the scientific world. Here will be seen wonderful scientific facts actually in progress that have in the past been known to us only in theory. The movement of the sun and the rotation of the earth, two phenomena little understood by many of us, can be studied and observed in the rotunda, for a coelostat telescope, mounted on the dome of the building, will reflect the image of the sun on a large white circular table beneath, in the middle of the room, and the sun spots, which to most of us are mere hearsay, can be seen moving across the disk of the sun and changing in number from day to day as the sun turns on its axis.

Suspended from this dome in the rotunda will be a pendulum which will demonstrate Foucault's famous experiment. This pendulum will swing in a steady arc always in an invariable direction, and as the earth rotates beneath it, this rotation will be clearly shown by the changed direction over a divided arc. In the rotunda, also, such well-known but little understood phenomena as earthquakes, electric and magnetic storms will be demonstrated. Here one will be able actually to see the visible growth of plants and bacteria.

Main entrance to the new building in Washington that will house the National Academy of Sciences and its subsidiary, the National Research Council

The seven rooms surrounding the rotunda are each to be devoted to a separate exhibit, and will contain the very latest results of scientific and industrial research. The National Research Council is made up of representatives from each Government bureau, each scientific and technical society and from every other research organization; therefore, each of these different branches are given one of these rooms for the purpose of showing the public the latest development in their line. In the room devoted to governmental research will be shown from time to time any new invention, development or discovery coming under their jurisdiction. Another room will be given over to the use of industrial research laboratories for the display of the results of their work. Universities, observatories and other institutions will bring their newest mathematical, astronomical, or chemical find, for the interested public to view and realize the progress being made constantly in these different fields.

The exhibits will of necessity be constantly changing, and progress will be the keynote, for each week will find a new wonder established in one of the rooms to interest and teach us the advance that is being made in the different branches of science. Nothing will be overlooked—the latest radio developments, some new synthetic chemical formula, or a newly discovered set of fossils. All will find a place in this unique building and will be examined with interest by visitors from all over the world.

This building will house both the National Research Council and the National Academy of Sciences—that organization which, since Lincoln's administration, has existed for the purpose of "investigating, examining and experimenting on any subject of science and art," and to be elected to it is the greatest honor than can be paid a scientist. Incorporated by Congress in 1863, it was originally limited to 50 members, but it has grown, since the limitation was removed in 1870, to a membership of 187, at the present time, with 36 foreign associates.

The Council, a war-time organization, was made permanent by act of Congress in 1918, and through its purpose of promoting research in mathematical, physical and biological sciences and in the application of these to the useful arts, is doing much to increase public knowledge and welfare. Although designated as an agent of the Academy, for the accomplishment of particular purposes, it has its own officers and membership, and determines its own activities and policies. The rented building which has been the home of these two organizations has grown much too small for their purpose, so the present site of the new building was purchased through the generosity of friends, and the building will be erected and maintained by means of the $5,000,000 contributed for the purpose by the Carnegie Corporation of New York.

Although this extraordinary museum will be of intense interest to scientists, it has been planned particularly with a view to instructing and attracting the general public. The Research Council has recognized the fact that it is becoming more and more necessary to demonstrate facts to the average mind, as the modern tendency is toward visualization rather than learning through the printed page.

Seeing to Taste

WHAT we know as taste is a somewhat more complicated sense than is commonly supposed. As a matter of fact with the sense of taste alone it is only possible to detect four flavors, which are sweet, sour, bitter and salt. All the more delicate flavors are discerned with the aid of the sense of smell. This is easily proved by holding the nostrils when eating any kind of jam, for instance. In such conditions it is quite impossible to detect the special flavor of the fruit. A yet more curious point is to be found in the fact that the ability to taste is to an extent, at any rate, dependent upon sight. Few people can detect the difference between beer and stout if they drink with their eyes closed. There are also a certain number of persons about who cannot tell tea from coffee if they shut their eyes when drinking. Most of the men blinded during the war lost all pleasure in smoking; they said the tobacco had no flavor to them. In many cases by using a stronger tobacco the lost pleasure in smoking has been regained. An interesting test for ordinary people is to close the eyes while smoking a pipe or a cigarette. It is amazing the difference that is made, proving beyond all doubt that seeing the curling smoke has a great deal to do with appreciating the aroma of the tobacco.

So all this seems to indicate that, after all, the senses of smell and sight are highly important in exercising our full sense of taste.

Our Point of View

A Second Naval Conference Proposed

HIGHLY significant was the recent vote in the House of Representatives, by a majority of 251 to 9, in favor of a clause in the Naval Appropriation bill, authorizing President Harding to "enter into negotiations with Great Britain, France, Italy and Japan, with the view of reaching an understanding or agreement relative to limiting the construction of all types and sizes of sub-surface and surface craft of 10,000 tons standard displacement or less, and of aircraft."

It was the expectation of Secretary Hughes and the officers of the United States Navy who assisted him in drawing up the famous 5-5-3 program, that the reduction of naval material would cover all classes of warships and not merely battleships and battle cruisers. The proposals of our Government called for this, and they were acceptable to Great Britain and Japan.

That the treaty failed to limit the strength in smaller vessels was due to the unexpected opposition of France, which was so uncompromising, that in order to save the conference from absolute failure, its provisions were limited to capital ships only. In this mutilated form the treaty was signed by the United States, Great Britain and Japan. It still awaits the signature of France, and consequently of the rival Mediterranean naval power, Italy.

Meanwhile the signatories of the treaty, feeling assured of the ultimate favorable action of France and Italy, have discontinued construction on all but the allowed number of capital ships and have put out of commission those ruled off the naval lists by the treaty. Great Britain, indeed, has already either broken up, rendered unfit for war, or placed on sale no less than eighteen dreadnoughts, including six battle-cruisers, among them Admiral Beatty's flagship the "Lion." The United States has sold the predreadnoughts "Maine" and "Missouri," and they are being broken up. The five predreadnoughts of the "Virginia" class were placed on sale, but they have lately been withdrawn from sale pending the unanimous ratification of the treaty. The Japanese are dismantling seven predreadnoughts; but they have stated that the hulls will not be broken up until all the powers have ratified.

The failure of the limitation treaty to cover the lighter naval craft is beginning to cause some uneasiness; mainly because of the great activity of Japan in the construction of these types, and of the fact that Great Britain, due to her great wartime expansion (she has laid down no cruisers since the war) possesses a preponderance in fast light cruisers, a type in which we are very deficient, although we shall probably complete six out of ten 7500-ton, 34-knot boats this year. On the other hand we lead the world in destroyers, with 281 against 185 for Great Britain and 53 for Japan. We lead also in submarines with 59 of from 500 to 1000 tons as against 36 for Great Britain and 28 for Japan.

The whole question is in an unbalanced condition, and therefore is only less provocative of uneasiness and suspicion than was the battleship situation. The House considers that it should be settled forthwith. The Senate evidently concurs; but, it would do well to finish one thing at a time, and settle the naval problem before taking up military disarmament—a question that fairly bristles with perplexities.

New York to San Francisco in 28 Hours

IN A recent address at Detroit, before the lately formed First National Air Institute, Colonel Paul Henderson, Second Assistant Postmaster-General, made public some extremely interesting facts regarding the Air Mail Service. At present it consists of a relay advance of mail from New York to San Francisco and vice versa—that is to say, the mail is picked up and carried ahead of the train mail, thereby gaining several hours at such cities as Cleveland and Chicago. The net result is that the Air Mail Service, every day, advances about 12,000 pounds of first-class letter mail by a matter of some three or four hours, and this, where the advance delivery is made late in the evening, means an actual advance of 15 to 18 hours. From July 16, 1921, to September 7, 1922, about 2,000,000 miles were flown without an accident, and on September 16 of the last year the service finished 10 consecutive weeks of flying the entire trans-continental route with 100 per cent efficiency; that is, to say, each trip was started and finished exactly on schedule time, in spite of the fact that the ships had to cross the three mountain ranges of the Alleghenies, the Rockies, and the Sierras.

The post office authorities realized that to get the full service out of an airplane it should fly by night as well as by day, and Colonel Henderson assures us that experiments and study of the question have reached a stage, where it is safe to conclude that it is entirely possible to fly at night. He believes that within a few months a night journey can be made from Chicago to Cheyenne, Wyoming. If that is successful, the carriage of mail will become a continuous movement, flying from New York to Chicago by day, Chicago to Cheyenne by night, and from Cheyenne to San Francisco during the early part of the second day. If the night experiment proves out, mail can be carried from New York to San Francisco in from 28 to 30 hours. The plan for night flying includes an emergency landing field every 25 miles, furnished with the proper lights and with a beacon light visible for a distance in excess of 25 miles. If the continuous mail service be established, it will go on record as one of the most valuable contributions ever made to the art of commercial aviation.

The Engine as a Brake

EVERY automobilist of touring experience has had occasion to use his engine as a brake. We refer not to the mild expedient of idling the engine while taking a moderate declivity, but to the whole-hearted measure of shutting off the ignition while leaving the engine in gear, so that it is carried through its cycle by energy abstracted from the rolling car. Though this is necessary in descending from the real mountains, there is a general failure to understand exactly what happens in the engine when it is done. The very term "running on compression," generally used though it is, is a misnomer, as may be easily seen.

At the end of the intake stroke the cylinder has its greatest capacity and contains a certain amount of air. At the end of the compression stroke it contains the same air, in a fraction of the original space. The air has been compressed in a definite ratio, and work has been expended in this compression. Then the piston recedes again, taking what would be the power stroke if there were any spark. The result of this dead return stroke is to relieve the air in the cylinder of its compression. It should be clear that every iota of energy spent in the compression is returned, during the dead stroke, by the pressure of the expanding air against the moving piston.

The compression stroke takes energy from the rolling car, the return stroke gives it back. Save for loss through friction and through leakage of compressed air past the rings, the net result of these two strokes together is zero. Whence then comes the braking power of the engine?

There is but one possibility of answer. On the intake and exhaust strokes, the engine pumps a volume of air through the intake, into and out of the cylinders, through the exhaust and back to the atmosphere. It is the energy absorbed by this pumping that provides the braking. Here there is no offset; the air has to be driven in, and it has to be driven out again.

But there is still room for fallacy. Thus, when we recently stated that there is no advantage in opening the throttle while braking in this way, numerous readers demonstrated, in questioning this, that the sequence of cause and effect involved is not a simple one. Some have overlooked that the compression is offset by the return stroke—if it were not, of course, it would be true that the more air admitted through a wider throttle, the more work the engine would have to do in compressing it. But some who avoided this pitfall still imagined that on the intake and exhaust strokes no work was done. With the piston open to the atmosphere on both sides—below through the breather and above through the valve—it was argued that there was atmospheric pressure on both faces of the piston, and that the latter moved without overcoming any resistance save that of its bearings. Most of our readers who took this viewpoint were honestly puzzled to imagine where the very considerable braking power of the engine came from, and to decide whether it could possibly be due altogether to internal friction.

The sequence of events on the intake and exhaust is itself most interesting, but we shall have to defer discussion of it until next month. In the meantime, perhaps some of our readers will be interested in figuring it out and comparing their results with ours. Perhaps some of them will even be keen enough to take their cars to the longest and steepest hill that is convenient, and learning just where, with a dead engine, the throttle should be set for maximum braking power.

The Turbine Locomotive

WE INVITE a careful study of the highly creditable results which have been achieved by the turbine locomotive of which a rather full description will be found on another page of this issue. In view of the great economies which had been realized by both the land and marine turbine, it was inevitable that serious attempts would be made to apply this type of prime mover to the locomotive; notable efforts to do this are the Ramsey locomotive which is now undergoing tests in England; and the Swedish Ljungström locomotive referred to above.

In applying the turbine, Ljungström decided to incorporate also the two features of steam super-heating and hot-water feed, which have been applied with such excellent economical results to the reciprocating locomotive. Additional economies have been secured by the use of hot draft, the complete enclosure of the working parts of the locomotive, and the use of forced lubrication. Judged by the consumption of fuel for a given output of power, this very elaborate and complicated locomotive has been a brilliant success, as proved by the fact that in hauling the same trains in competition with the Swedish standard locomotives the fuel bill has been cut in half.

So far so good; but we must remember that the saving in fuel must be heavily offset by the very great cost of construction. A first-class locomotive, designed for heavy American service, costs today from $40,000 to $60,000; and it takes but a cursory examination of the Ljungström locomotive to realize that if one of this type were built in American shops, it would cost at present prices three or four times that amount. If so, the question arises as to how far the interest on the excess cost would go to offset the economy of operation. In drawing attention to this fact we have no wish to detract from the great credit due to the Swedish engineers for the brilliant results which they have obtained.

A Chain Cable Problem

FROM far Australia a correspondent asks us to explain how such great chain cables as those which will support the Hudson River bridge are linked up in midair across the opening of over 3000 feet between the banks of the river. He can understand how a continuous wire can be woven back and forth to form a wire cable, but he cannot conceive how it can be possible to support the many thousands of I-bars while they are being pinned together to form a self-supporting chain. Doubtless, this problem has exercised the thought of a great

Our Point of View

many of our readers, particularly in view of the great size and weight of these particular chains.

There are four main cables, each made up, transversely, of 81 eyebars, arranged in three superposed chains. Since these are assembled at their ends upon a common pin, the total width of one chain is about 12 feet. Each I-bar will be, say, two inches thick, and 54 bars must be assembled, side by side, on each pin, 27 of them pointing toward one tower of the bridge and 27 toward the opposite tower. Now, considering that there are nearly 20,000 I-bars in the four cables, it can be seen that the problem of erection is of stupenduous magnitude. Nevertheless, it is actually a simple operation.

Let us suppose that the anchorages are completed and that the two towers have been built to their full height. The first operation is to construct a working platform carried on wire cables and extending the full length of the bridge. Along this platform the pins are assembled at intervals of about 60 feet, corresponding to the length of the I-bars. Next, a single I-bar chain is formed by threading upon the pins alternately a single and a pair of I-bars, these being slipped over the pins until they lie at their centers. When this has been done we have a very strong chain extending from anchorage to anchorage, and securely pinned to them and to the tops of the towers. This chain is now independent of the platform, and the building up of the chain continues until the chain contains its full quota of I-bars. Intermediate with the I-bars there are also threaded into place on the pins the vertical suspenders and the diagonal members of the chain trussing. When this work has been completed for the whole four chains, the work of attaching the floor of the bridge proceeds until the whole structure is complete.

An Undivided Fleet

WITH the opening of the Panama Canal it was naturally expected that the Pacific and Atlantic Fleets would be combined in one mobile force, capable of being transferred at short notice from the Atlantic to the Pacific or vice versa. To the amazement of naval strategists, Mr. Daniels' administration divided our main fleet and placed one fleet in the Pacific and the other in the Atlantic. Each unit was absolutely self-contained, independent, and under a separate command. The system was pernicious from every point of view except perhaps the political one, and, in spite of the earnest protest of practically the whole of the technical advisors of the navy, this separation was maintained. The chief disadvantage was that there was a lack of that combined training, and of those maneuvers under a single commander-in-chief, which naval history teaches are essential to efficiency in the day of battle.

Furthermore, the country was put to great additional expense by maintaining the most important half of our battleship fleet on the Pacific coast; for the sources of coal and fuel supply, the principal dockyards, the principal engineering works and machine shops of the country, and the leading firms from which the navy draws its huge supplies of food, clothing, etc., are all concentrated west of the Mississippi, and mainly on or near the Atlantic seaboard. Therefore, there has been a continual and heavy expense in shipping material and supplies across the continent. To this was added the increased outlay to cover the traveling expenses of officers and men on furlough, for most of these have their homes within relatively much easier reach of the Atlantic than of the Pacific coast. For these and many other reasons, therefore, we welcome the reversal of the policy adopted under Mr. Daniels' regime, and the announcement by the Navy Department that hereafter there is to be consolidation of the two fleets into the "United States Fleet." Admiral Jones will be in supreme command, with Vice-Admiral Eberle serving under him as commander of the battle-fleet unit. There will be a scouting fleet commanded by Vice-Admiral McDonald, and a control force to support the operations of the fighting fleet under Rear-Admiral McCully. Finally, the "fleet base force," composed of mine, destroyer and aircraft squadrons, will be under Rear-Admiral Chase.

By thus utilizing to the full the strategic value of the Panama Canal, the United States is able to present in either ocean a single, highly organized, thoroughly trained fleet, including our first-line battleships, backed up by all the accessory cruisers, destroyers, submarines, mine layers, aircraft, repair and supply ships which go to make up a perfect, modern, fighting fleet.

A Plea for Decency and Comfort

IT IS an invidious task to criticize any part (and especially such a very essential part as the sleeping car) of a railroad system which has given to the world the Pullman car, the dining car, the chair car, and the observation car, and by the invention of the vestibule has made the whole length of a train available for passenger movement. Nevertheless, it is a fact that our sleeping car arrangements for dressing or undressing morning and night, for washing, shaving and sanitation—to say nothing of the provision for sex separation and privacy—are about as unhappily contrived as they can well be.

If there is one vice from which, as a nation, we are surely free, it is that of a blind, unreasoning conservatism; and yet the fact that the standard sleeper of today conforms so closely to the arrangements which were found in its original prototype of over half a century ago, will seem to prove that, here at least, we are under the spell of a blind tradition.

In the endeavor to get into or out of his clothes, the traveler has to choose between dressing in the aisle, or the performance of weird, acrobatic feats within the narrow compass of his berth. For his morning ablutions he must bump his encumbered way through the car, to find himself crowded into a smoking room (for the time being extemporized as a dressing room) where he shaves at the peril of an accidental jolt to his elbow, and washes—or waits—as the gods may decide.

As for the unhappy occupant of an upper berth, when he comes to retire let him find such comfort as he may from the reflection that his ancestors of two or three centuries ago went to bed, many of them, by way of a stepladder and thought nothing of it; but that half the occupants of a modern sleeper should have to reach their couch by the same means is, to say the least, a strange anachronism.

Now this question of sleeping car construction is a technical matter, and it is capable of satisfactory solution. The stateroom cars in this country and on the Continent (where, by the way, they are universal) prove that it is possible to ensure a decent separation of the sexes, and not only provide absolute privacy but make each two-room apartment a separate day and night room, with its own individual conveniences.

Nor can we see why the separate stateroom sleeper should call for a much higher fare. Structurally, there is involved, it is true, the building of partitions and the provision of individual lavatories; but if the system became universal, the cost of these would be proportionally reduced. Assuredly, a grateful public would be willing to pay a moderate increase over the present rates, in exchange for a decent degree of privacy and the many comforts which go with a separate room.

The Rebuilding of France

RATHER quietly, considering the magnitude of the task, but very persistently, the work of restoring the ravaged portions of northern France has been carried on, with results that are perhaps too little known, and not sufficiently appreciated by the general public. The subject was recently brought to the attention of the American people by the announcement of the American Committee for Devastated France that it had held its last annual meeting. It is gratifying to know that the greater part of this huge task has been completed; nevertheless, it should be clearly understood that there is yet a great deal of arduous work to be done. Although 741,883 buildings, that had been destroyed or seriously damaged, have been reconstructed or put in order, there are still over 200,000 such buildings that have yet to be rebuilt. Of the vast expanse laid waste by shell-fire and broken up with trenches, over 5,000,000 acres have been restored and cleaned up by the removal of barb-wire, shells, and so forth. But there are 4,000,000 acres that remain today in the condition in which they were left by the retreating German armies. We are told that nearly 23,000 destroyed factories have been rebuilt; but 3000 factories are still in ruins.

The work of the American Committee is a "record of homes rebuilt, of fields won back to cultivation, of agriculture reorganized, of infant mortality reduced, of standards of living raised, of social conditions improved, and of help given to children and parents." All honor to the American women for the work which they have done so quietly during the past few years in the devastated regions of France.

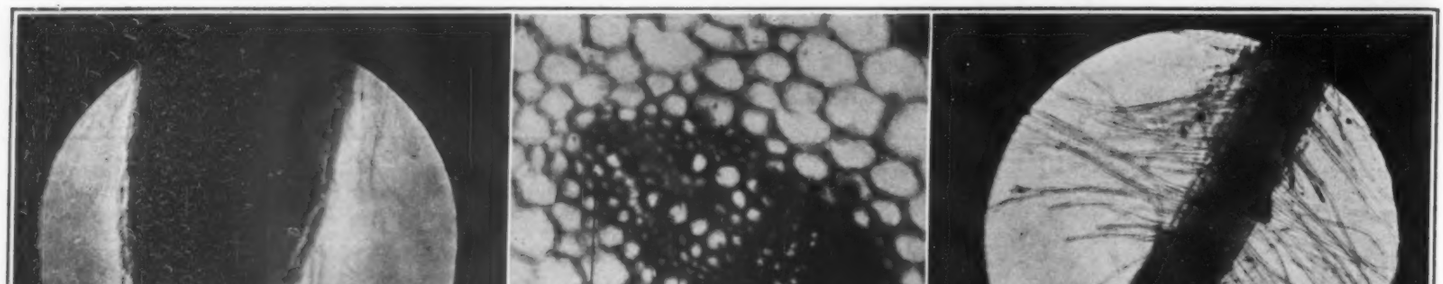
The activities of the French government have been prodigious, as may be judged from the fact that the whole of the smashed-up railway system has been reconstructed; bridges, many of them of the first importance, have been rebuilt; to say nothing of the reconstruction of the canal system and the restoring of the famous French highways to first-class condition. It is upon the vast sums that she has spent in this work that France bases chiefly her claim for compensation.

Locks No Hindrance at Panama

THE impressions of Dr. Emery R. Johnson of the University of Pennsylvania, on his recent return from a visit to the Panama Canal, carry a special interest from the fact that he was a member of the first Isthmian Canal Commission, and Special Commissioner on Traffic and Tolls in 1912. Dr. Johnson's report of the prospects of future trade and revenue, made at the time when the United States was taking hold of this great project, is a classic among literature of this kind. Highly satisfactory is his statement that the revival of business in recent months has given the Panama Canal a large increase of traffic, the revenue from tolls for the last two months having been $150,000 a month in excess of any previous record. If the present traffic continues until June 30, 1923, the Canal will have been used by about 14,000,000 tons of ships in the 12 months. This total, however, calls for the passage of only 10 vessels a day, which is "only a fraction of the business the Canal is capable of handling." The waterway is fully lighted, and, whenever future traffic calls for it, operation by night will be entirely feasible. Consequently, the canal can accommodate four times the present volume of traffic.

Commenting on Mr. Bunau Varilla's advocacy of a sea-level canal, Dr. Johnson makes the surprising statement that a sea-level canal "would be no more efficient than the present canal," and he proves it by pointing out that the capacity of 50,000,000 tons per year of the existing lock canal can be readily increased by adding another series of locks and converting the present twin locks into triple locks. The increased water supply, as we have lately pointed out in these columns, can be secured by the construction of an additional dam at Alahuela, across the Chagres River.

It is gratifying to learn that the passage of the six locks in the present canal does not increase the time taken by a vessel in crossing from ocean to ocean. Dr. Johnson made this trip on a Grace Line freight-and-passenger vessel in 6 hours and 10 minutes, from anchorage at Balboa to the pier at Colon, and 2 hours and 19 minutes of that time was consumed in the passage of the locks. In a tide-level canal the average speed could not be above six miles an hour, with a minimum time of transit of seven hours. The transit of the Suez Canal, which, of course, is tide-level, is made at about this speed.



Left: Root end of tradescatia, showing root tip and cap. *Center:* Cross section of vascular bundle in lily of the valley: 1, the phloem; 2, the xylem; 3, the bast. *Right:* Root of tradescatia showing root hairs. This has a magnification of about 25 diameters; the two other views about 150

Details of typical root structures, showing where the circulatory system of the plant begins

The Heart and the Heartbeat of the Plant

The Work of Distributing Moisture and Sustenance, and the Way in Which it is Done

By Dr. E. Bade

THE ROOTS of a plant, penetrating deeply into the soil, firmly anchor it to its place of support. There are thousands of such tiny roots which not only divide and subdivide, but are sent in all directions. The fine, delicate points of the growing root tips, always creeping forward under the soil, are protected by a cap somewhat resembling a thimble. Behind this tip, the soft root hairs are developed. The water from the soil, which precipitates as dew or rain, is absorbed by them after it has dissolved out the salts of the soil. That which is taken up by these innumerable mouths of the root hairs is passed along, as by a never ending chain of buckets, from root to trunk, from trunk to limb, from limb to twig, and from twig to leaf. Here the greater part of the moisture is evaporated, but the salts are retained and utilized.

The rise of the sap from the finest of root hairs to the tip of the leaves can be likened to the action in the veins and arteries of the higher animals. In the plants it is the conducting vessels, or fibro-vascular bundles, which carry the necessary moisture. These can be divided into two parts, those which are hard, the xylem, and those which are soft, the phloem. The xylem conducts the salts and moisture from the root hairs to the assimilating laboratory which is, primarily, the leaf. Here the salts and part of the water are chemically bound together and the rest is evaporated, the phloem conducting the food where it is needed.

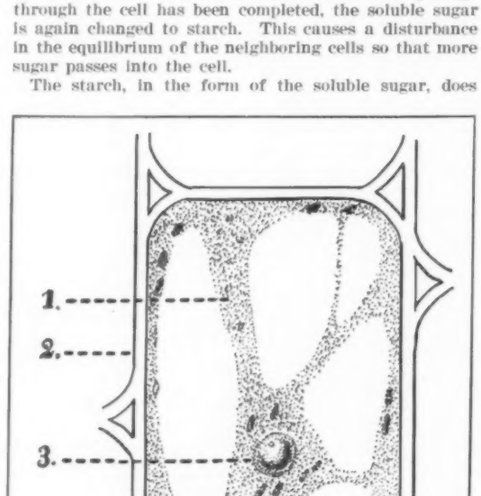
In the leaves, the first thing which is manufactured with the aid of chlorophyll and light from inorganic raw products is starch. This is a combination of carbon dioxide and water. Carbonic acid is first formed; then two molecules of this acid are taken by the plant and changed into formic acid with the liberation of free oxygen. The formic acid is still further utilized and changed into formaldehyde whereby free oxygen is again formed. Six molecules of the formaldehyde are next condensed into one molecule of grape or invert sugar. If one molecule of water is now extracted from the sugar and the result treated by a process of polymerization, starch is formed. The successive steps are indicated by the following formulae:

$$H_2O + CO_2 \text{ (carbon dioxide)} = H_2CO_3$$
$$2H_2CO_3 = 2CH_2O_2 \text{ (formic acid)} + O_2$$
$$2CH_2O_2 = 2CH_2O \text{ (formaldehyde)} + O_2$$
$$6CH_2O = C_6H_{12}O_6 \text{ (grape sugar)}$$
$$C_6H_{12}O_6 = C_6H_{10}O_5 \text{ (starch)} + H_2O$$

Starch can be considered the basic principle of practically all other plant substances. From this material the carbohydrates, sugar and cellulose, are produced, the fats and proteins are formed and of great importance is asparagine. These three classes of compounds are sufficient for the formation of all plant organs.

The wanderings of those substances produced in the leaf can only be followed directly in one case with the microscope, the substance observed in this manner being starch. Since an open transportation system is lacking, all substances must pass through millions of closed cells. In order to transfer the starch from cell to cell, it must first be prepared for the journey. This is accomplished with the aid of enzymes. These are peculiar substances of incompletely known chemical composition having a wonderful peculiarity, minute quantities being able to split up relatively large amounts of insoluble substances into smaller molecules. One of these enzymes is, among many others, diastase, which splits starch into dextrin and sugar. These compounds are soluble and are able to pass through the membrane of the cell wall. After the passage through the cell has been completed, the soluble sugar is again changed to starch. This causes a disturbance in the equilibrium of the neighboring cells so that more sugar passes into the cell.

The starch, in the form of the soluble sugar, does not, therefore, pass in an unbroken and uninterrupted stream from cell to cell, but is dissolved, passes through the cell wall, and is reprecipitated. This process is repeated again and again as cell after cell is passed until the starch arrives at the point where it is required or where it is to be stored. It is undoubtedly true that the passage of the split albuminoid substance is carried on in a similar way, but it cannot be directly observed.



1: Protoplasm. 2: Cell wall. 3: Nucleus. 4: Chromatophores. 5: Vacuoles

The heart of the plant, a cell that pulsates regularly, pumping the sap from a lower cell to the one above it

The problem of how the sap rises from the root-hairs to the tip of the leaves has not, as yet, been satisfactorily explained. It is known that the sap or water rises in the xylem. In a tree the quantity of water taken up is quite considerable, about 50 liters being required by a large species, and in the gigantic trees, it must be raised for more than 450 feet. The so-called root pressure is able to lift a column of water quite a distance into the air, but in the problem of the rise of sap it only plays a secondary part, for the greatest possible available pressure is far from sufficient to lift the water to the top of the highest trees. Then, too, this root pressure cannot be proven present throughout the year. Atmospheric pressure can lift a column of water only to a height of 34 feet. Capillarity itself is too restricted in action to have much of an effect, and osmotic pressure is far too slow to be responsible; for it has been proven that sap rises more than 100 feet an hour. Even the suction of the leaves fails to explain this phenomenon for, by experiments made with a plant whose roots have been cut off, its leaves removed and its stem covered with an impervious varnish which prevents respiration, the plant was still able to absorb water when the cut end was placed in a vessel, and the water rose at the rate of 60 feet an hour. The rise of sap can therefore only be explained by the action of the cells. Here is where the most recent observations of Sir Jagadis Chandra Bose, an Indian naturalist, come in. He examined, in order to find the seat of the power in the individual cells, all layers of cells from the bark to the central cylinder and pith, while they were still in their fullest activity. For this purpose he used a special magnetic instrument (crescograph), which enlarged all changes within the cell from 10 to 100 million times. In this way all detailed movements of the cell were observed. With the aid of an electrical instrument the investigator penetrated deeper and deeper into the center of the plant, and, by the deflection of a galvanometer which recorded the tiniest movements of the cell, he found that they expanded regularly, took up sap and then contracted and passed the sap along. The cells within the plant pulsate regularly, expand and contract, millions of tiny "hearts" pump and lift the water, take it from below and, on contraction, press it upward from one cell to the other. The rate of pulsation is approximately 14 seconds, but under the most favorable conditions this is much more rapid while under unfavorable conditions the pulsations slow down until they stop entirely.

Most Powerful Reciprocating Steam Engine Ever Built

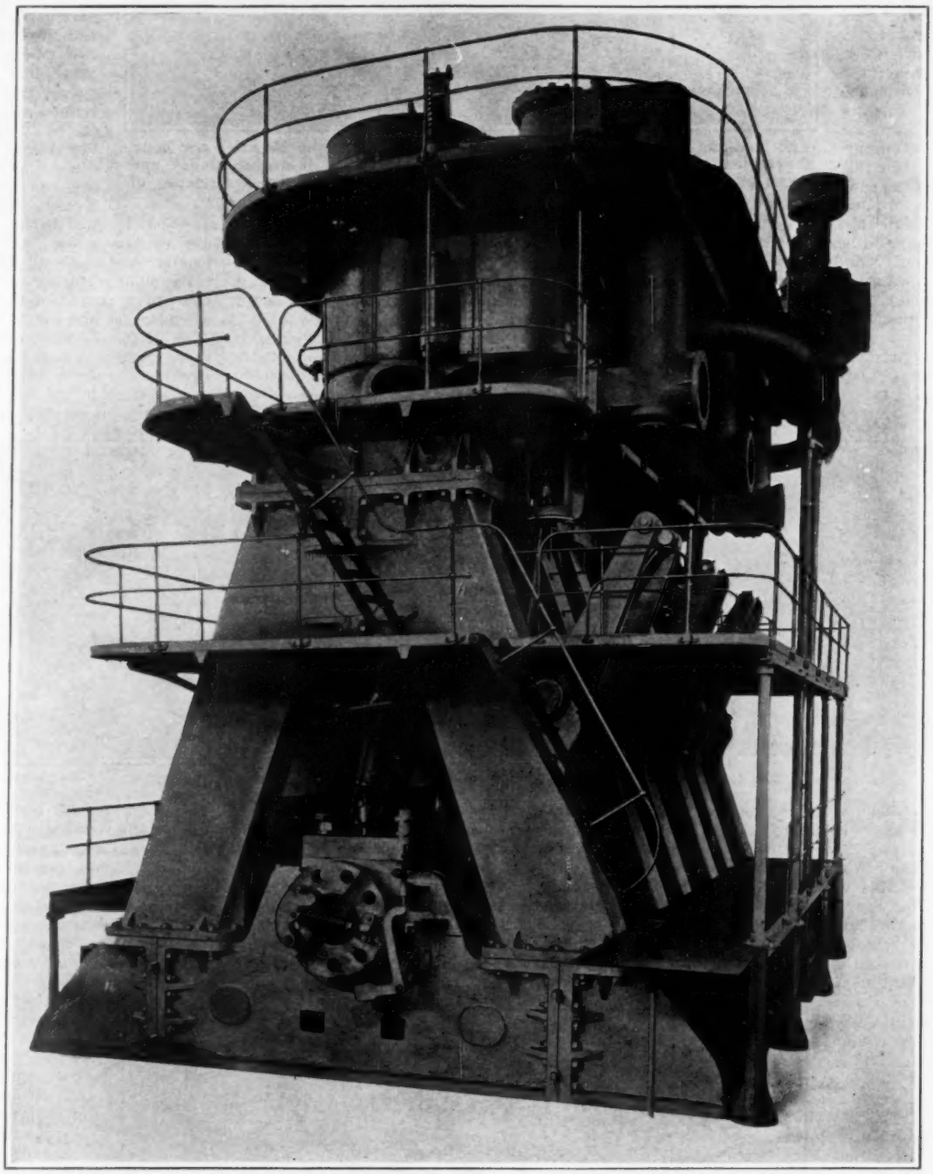
IT is doubtful if there is any work performed by the reciprocating steam engine that imposes such heavy stresses and shocks upon the prime mover as does the reversing, rolling-mill engine. Not only does it suddenly and many times a minute overcome the inertia of its own heavy moving masses, but it has to do the same with the ponderous rolls and traveling tables of the rolling mill itself. Any one who has watched the rolling of rails, I-beams, and large sections, will be inclined to agree with this statement. Hence, the rolling mill engine must be built of the best materials, of great strength, and with a special eye to the solidity and strength of its foundations and holding-down bolts.

The massive engine which forms the subject of our illustration is claimed to be the most powerful high-pressure steam engine ever built—a claim to which its horsepower of 25,000 would seem to entitle it. The engine was constructed for the Cargo Fleet Iron Company, for the purpose of rolling heavy joists up to 12 inches in width by 24 inches in depth; and it is interesting to note that the builders, Richardsons, Westgarth & Co., of Middlesbrough, England, have guaranteed that the engine will be capable of reversing four times in a minute; a performance which will be largely due to its special system of valve gear.

A fundamental necessity for a reversing engine of this great power was the provision of a large base to prevent the rocking action of the engine. Security also demands a specially strong foundation. It will be noted that the Y-frames have an unusually wide spread. Into a massive concrete foundation there is imbedded an unusually heavy bed-plate 22 feet in width by 29½ feet long, and weighing 105 tons, which is built up as follows: On each side there are longitudinal box-shape cast-iron girders, heavily ribbed, four feet in depth. Connecting these longitudinal girders together are six cross girders of box section, each of which carries one of the main bearings. The cylinders are mounted on six cast-iron, Y-shaped columns which are strongly bolted together and are also held by two forged steel hoops 12 inches in diameter, which are shrunk upon bosses cast for this purpose on the two halves of each Y-frame. The crosshead shoe guide-plates are six inches thick, and are cored out so that water circulation can be used should it prove to be necessary. Upon the Y-frames is bolted the entablature which is two feet deep, and upon this are mounted the three cylinders.

The cylinders, each 45 inches in diameter by 52 inches stroke, are operated under a steam pressure of 190 pounds to the square inch, with 100 degrees of superheat. The maximum allowed speed of revolution is 140 per minute, and at this speed and steam pressure the engine develops 25,000 horsepower, and exerts a torque of 417 foot-tons.

The cylinders are duplicate castings of close-grained iron, and they are fitted with liners 2½ inches thick, which are forced into place by hydraulic pressure. The valves, of the piston type, are 20 inches in diameter at the top and 19⅝ inches at the bottom, this variation serving to balance the weight of the moving parts by steam pressure. They work in hard cast-iron cylinders and take steam at the center. The steam is admitted to the cylinders through a separate 14-inch, double-beat throttle-valve, placed close to the piston valve chamber, in order to secure quick control by reducing to a minimum the amount of steam between the valves and the cylinders. The three individual valves are coupled together so that they can be operated simultaneously from the driving platform. This is done by means of a steam hydraulic reversing engine. The valve gear is of the Joy type, arranged to cut off steam up to 70 per cent of the stroke.



This 3-cylinder, reciprocating engine, designed for rolling heavy 12- by 24-inch I-beams, develops 25,000 horsepower at 140 revolutions per minute, with steam at 190 pounds. The three cylinders are 45 inches in diameter by 52-inch stroke; and it can reverse itself and the massive rolls which it drives four times in a minute. Note the wide spread of the frames and the massive construction designed to take care of a torque of 417 foot-tons

The most powerful reciprocating engine ever built

In a reversing engine it is, of course, desirable that the reversing mechanism shall operate in the shortest time possible, and the reversing gear engine has a steam cylinder 13 inches in diameter by 22-inch stroke. This engine is carried between the frames of the first and second cylinders.

The main crank shaft is in three pieces. They are bolted together through flanges, and are interchangeable. Each section is built up with two webs and a pin forged out of one ingot. There is a 5-inch hole bored through the shaft and pins. The shaft, which is 22 inches in diameter, weighs 40¾ tons. The pins are 23 inches in diameter by 20 inches long. The six main bearings carrying the crank shaft are 22 inches in diameter by 24 inches long; the bottom and top halves are semi-circular cast-iron bushes, cored for water circulation, and they are lined with white metal containing 62 per cent of tin.

The connecting rods are 8½ inches in diameter at the top and 10 inches at the bottom; the piston rods are 9 inches in diameter, and are made of forged nickel steel. The pistons are cone-shaped steel castings, machined all over; they rest on a collar on the piston rod, and are secured by deep, forged-steel nuts, screwed 8 inches in diameter.

In addition to the three main throttle valves above mentioned there is also an emergency master valve in the main steam pipe. This is normally held open by a hydraulic ram; but if the speed of the engine rises more than 12½ per cent above 140 r.p.m., the centrifugal weight, which will be noticed in our illustration on the end of the crank shaft, trips a lever and allows a vertical spindle to fall; which lets the water in the ram escape, causing the emergency valve to close. For our photographs and data we are indebted to *The Engineer*, and the builders.

Small Automobile Driven by Storage Battery

SMALL automobiles, which have been brought out on the market for the past years, have been built in such a manner that gasoline or benzol is used as the source of the driving power. Recently a manufacturer in Wurttemberg, Germany introduced a new electrically-driven small automobile into the field. It is claimed that this automobile possesses certain undoubted advantages. In the first place it can be operated more cheaply with electrical power than with liquid fuels under present conditions. In the second place the driving mechanism, connecting the motor with the wheels, is much more simply constructed in the electric automobile. The upkeep of the machine is less costly, likewise, and the care that has to be given to the automobile is by no means as great as in the gasoline-driven cars.

The car is started by simply pulling a lever, located alongside the driver's seat. The radius of action of the electrical machine has been made so large at the present time that it will meet all the demands put upon it by city and country traffic. The new electric car travels at a maximum speed of 20 to 30 kilometers per hour and can go up grades up to a maximum of 15 per cent. The storage battery is located in the fore-part of the machine and is proportioned in such a manner that the car can travel 80 to 100 kilometers and return on a smooth, level road. If the car is driven during the day, during the night it may be connected with any source of direct current supply through an intermediate resistance of the proper capacity, and the battery may be recharged, so that the machine is ready to go out the next morning.

Alternating current can be used as well for charging, when a suitable device is interposed between the battery and the source of current to rectify the same. On the instrument board of the automobile there is located a suitable contact plug, to which the cable from the current supply can be conveniently connected.—*Technik fuer Alle*, 1922, page 93.

An Amphibious Military Tank

A SUCCESSFUL demonstration was recently made before officers of the War and Navy Departments, and members of the American Society of Mechanical Engineers, of a new type of military tank which can travel on land and water. It is the design of Walter Christie, who is well known as the originator of the front-wheel drive for trucks and automobiles. The tank was driven on the level road at a speed of 25 miles an hour; climbed a slope of 40 degrees at the foot of the Palisades of the Hudson. Returning to the bank, it moved down into the water, and, against a strong tide, crossed the river where it is nearly two miles in width, under its own power.

The land-and-water tank with these rubber tires can make 25 miles per hour. It carries caterpillar treads on which it can climb 40-degree slopes and cross ploughed fields. The watertight body enables it to cross stretches of water

As we have frequently stated in these columns, the efforts of the Army Ordnance Department of the United States Army have been directed, particularly since the war, to increasing the mobility of our artillery. Among the means by which this has been secured is that of mounting each gun upon its own self-driven tractor; and the tests which have been made show that we are now possessed of both field and heavy artillery, which can traverse a rough country and climb steep grades with remarkable facility. As a matter of fact the new guns can traverse almost any terrain, and they can be stopped in their progress only by the presence of deep water.

The amphibious tank of Mr. Christie is designed to extend still further the mobility of field artillery by enabling it, under its own power, to cross any river, pond or marshland that it encounters. The body of the tank is a plate-steel, watertight structure of a general "T" shape, the vertical portion of the "T" extending between the wheels and the upper portion overlapping the wheels as shown in our illustration. The broad upper portion serves to give the required buoyancy and stability when the tank is afloat.

The land-and-water tank crossing the Hudson River under its own power

For rapid land travel on the highways or other good surface, the tank runs upon solid rubber-tired wheels. At the rear end of the tank is an extra pair of wheels which, when the tank is running on the road, are sufficiently raised to clear the surface.

When the tank leaves the road to run across country, it is equipped with caterpillar chains which are carried among the spare parts in the tank. The placing of the chains is generally done by laying them out on the ground in front of the wheels, running the tank over them, and coupling them up in place. The climbing ability of the tank as thus equipped was tested after it had been taken over the Hudson River to the base of the Palisades, where it climbed a hill with a grade of about 40 per cent, after which it was turned around and run to the bank of the Hudson River. Here two propellers were attached to the shafts which project from the rear of the under-water body, power being obtained from the motor. The machine then descended the sloping bank and ran over the river bottom until it was afloat. The Hudson at this point is nearly two miles in width and a strong ebb tide was running. The tank took about 45 minutes to cross to the Manhattan side.

The present test tank mounts a 3-inch field gun, and it has sufficient capacity to carry also a crew under shelter and sufficient supplies and ammunition to last for the probable length of a day's service.

The Perpetual Calendar

SINCE there are only seven days of the week, it is clear that the calendar for January can present only seven variations. That for February, up to the 28th, must follow along after that for January. Then we have a choice whether it is leap year or not; and for the balance of the year there are these two alternatives. That is to say, the calendar for the entire year must follow one of 14 set models.

Again: every month must begin on one of the seven days. After it has begun, its calendar, *as far as it goes*, is the same regardless of whether it is December with 31 days, or April with 30, or February with 29 or 28.

On this basis, the making of a universal calendar that shall, after some method of selection, be good for every year, past or present or future, presents no great difficulty. We need but present seven monthly outlines, together with a means of selection between them. This means might take the form of listing the years, from one to some convenient upper limit, with a key letter after each which would refer us to the proper monthly schedules. But it might better be of mechanical nature, so that after setting certain parts of the adjustable calendar-sheet of metal or heavy card, the selection would be made for us.

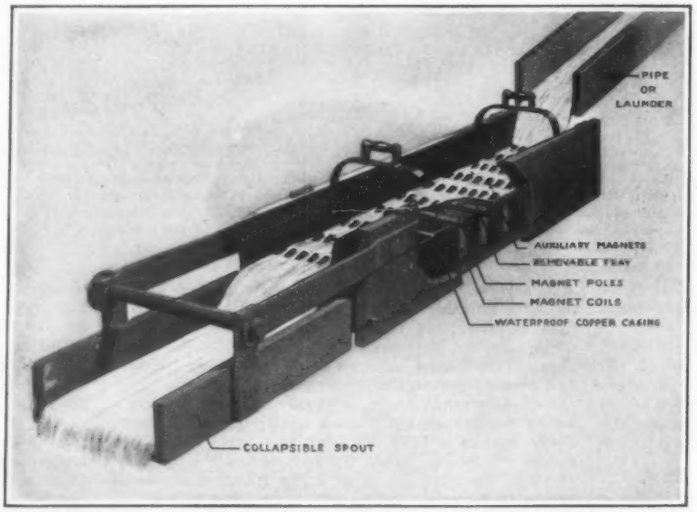
A New York publisher has just put out an extremely clever calendar of this sort. One "sets" a little metallic button opposite the appropriate century, moving the button up and down to effect this setting. This button carries with it a cyclic arrangement of year numbers running from 1 to 99; according to the century, the year-table occupies one or another position. One then sets another button opposite the appropriate year. This motion carries with it that of a rectangular array of days. There are seven columns in this and each starts with a different day. One column is for January and October, which always have the same calendar in normal years. A second is for February, March and November, of which the same is true as far as each month goes. A third is for April and July, and January in a leap year. May and June each has its own column, since these months duplicate no others. Leap-year Februaries are always like Augusts, and go in the same column. Finally we have a column headed September and December. The setting of the second button insures that each column will begin at the right place—with Monday or Wednesday or whatever other day is appropriate. And that's all there is.

By simply setting the two buttons—which can be done in a couple of seconds—one has immediately a calendar for the entire year, and for any year from 1 to 3199. By ignoring the 29th, 30th and 31st for those months which have not 31 days, this calendar is perfectly simple to read. Both for those who wish one calendar to last for many years, and for those who have frequent occasion to consult calendars of past or future years, this should be an extremely convenient device. It carries full directions for use.

Magnetic Separators for the Ceramic Industries

THE raw materials from which pottery is made contain considerable iron in one form or another. In addition, the process of manufacture involves the use of steel grinding tools, and from these minute particles break away and become incorporated with the clay. Then, too, there is the larger iron in the form of bolts, nuts, nails, screws, wire, etc., which so unaccountably yet so infallibly finds its way into materials shipped in bulk. These remarks are as true of the glass industry as of the clay; and in all cases it is necessary that the foreign metallic material be removed.

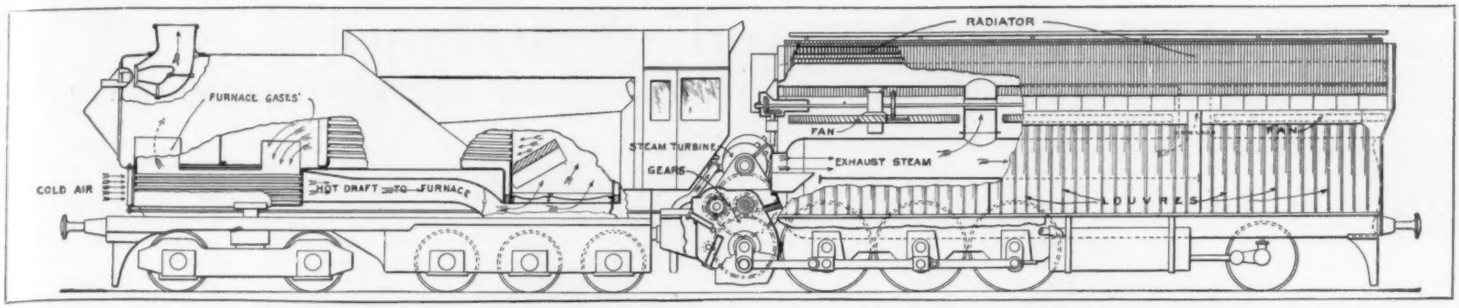
Magnetic separators are not especially new; but they have in the past been used mostly for the separation of iron from other metals. There is now available a separator designed particularly for use in handling the saturated or partly saturated solutions of the ceramic industries. It is equally available in the manufacture of ink, where the necessity of freeing the product of metallic iron again present; and it is available in making paper and rubber, and, of course, wherever material in a semi-liquid form must be freed of iron.



A magnetic separator designed especially to handle the semi-liquid materials of pottery and the allied industries

One of the features of the apparatus, as illustrated, is the series of staggered magnets in the tray. In passing over and through these, every part of the material comes in contact with a magnetized surface. The magnets employed are electromagnets, and much more powerful than the familiar permanent magnet.

To warn the operator against any interruption of current which would de-energize the magnets, a pilot lamp burns as long as the current flows; or if the separator is in a remote place an alarm bell rings on the interruption of the circuit. The spout that delivers the cleaned material collapses when the magnets cease to be operative, thus preventing the delivery of an accumulation of metal into the separated mass. There are no moving parts, not even in connection with the electro-magnets.



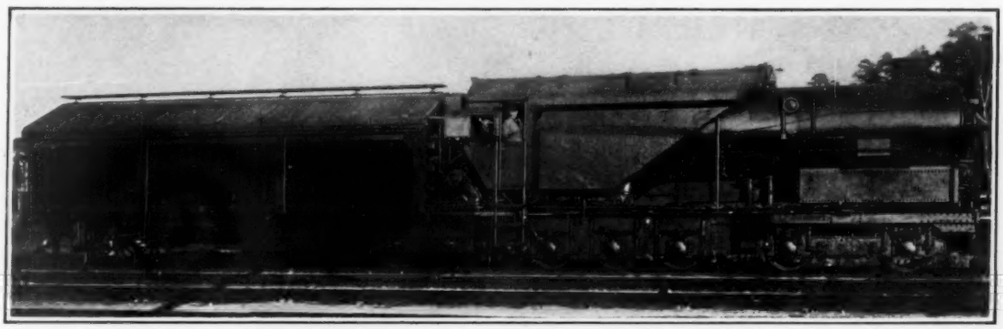
This drawing shows the novel arrangement of the Ljungström turbine locomotive. The engine and driving wheels are transferred to the "tender," which also serves as a huge, air-cooled radiator for condensing the steam. The coal is carried above the "locomotive"

A Turbine Locomotive Which Saves Half the Coal

THE simple high-pressure steam locomotive with a reciprocating engine is known to be an extravagant consumer of coal; a consumption of four pounds of coal per horsepower being a not unusual figure. Naturally locomotive engineers have attacked this problem, and by the substitution of improved valve gears and valves; by a better proportioning of the various elements of the locomotive; and above all by super-heating, they have realized valuable economies. The latest and most successful efforts to improve the coal consumption has been the applying of the principles of stationary engine practice to the locomotive. The present article is devoted to an extremely interesting and very successful attempt to do this by the engineers of Sweden, who have built a remarkably successful steam-turbine condensing locomotive.

That the new locomotive must have been very costly to build no engineer can dispute; but the fact that in competition with standard simple steam locomotives and when hauling the same trains, the new type has cut the fuel bill in half, must oblige any candid mind to admit that it is not only a brilliant vindication of the theories upon which it was built, but that if it stands up to its work it must inevitably mark a new era in the history of the locomotive.

The Ljungström locomotive is named after its designer, a well-known engineer of Stockholm, Sweden, to whom we are indebted for the illustrations and descriptive matter in the present article. It takes but a glance at the accompanying longitudinal view to see how radically the new type differs from the standard type with which we are all familiar. In the first place, the engine has been removed from what is commonly known as the locomotive, and built upon the forward end of what we have hitherto known as the tender. Furthermore, the locomotive frame carries merely the boiler and the coal bunkers, which are of the saddle type and are placed on the top of the boiler just in front of the cab. The engine, which is of the steam turbine type, is carried at the forward end of the tender, which it will be seen is of unusual dimensions. The tender acts the part of a huge condenser, the condensing taking place in a great nest of tubes which are air-cooled. Speaking in motor car parlance, the tender, or rather the roof of the tender, is a huge air-cooled radiator. Another point of difference is that the driving wheels are placed beneath the second element, or what in this country would be the tender, of the locomotive. They are six-coupled and are driven from the turbine through a double reduction gear.



Side view, showing the coal bunkers above the boiler. Note the vertical louvres in the "tender," through which the air enters to pass out through the copper tubing in the roof, in which the steam is condensed

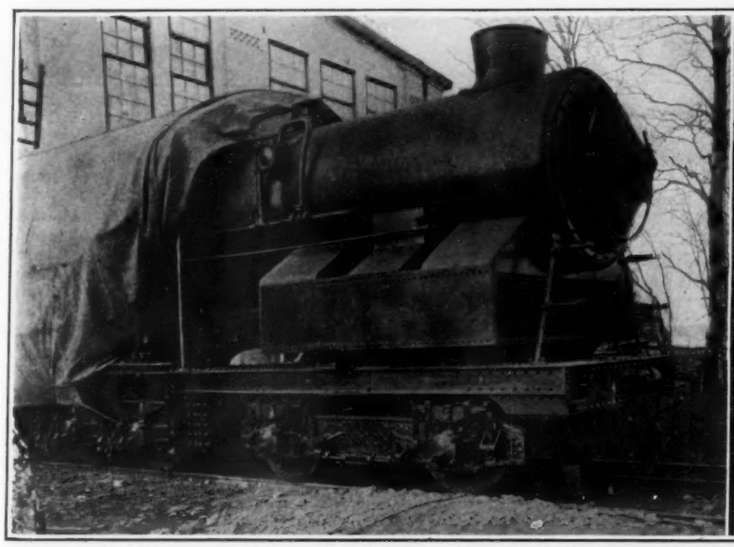
There is not any portion of the locomotive which has not been attacked by Ljungström in the endeavor to realize all possible economies. In the first place, with regard to the boiler the forward third of the fire tubes, which has long been known to be of small evaporative efficiency, has been cut away, and the smoke-box thereby greatly enlarged. The smoke-box is divided at about its center by a vertical diaphragm and at the base of it is located a large nest of brass tubes. The furnace gases leave the ends of the tubes at 320 degrees heat Centigrade, and by means of the smoke-box diaphragm they are caused to pass down through the nest of tubes, and up to the smokestack on the forward side of the diaphragm. The forward ends of these tubes are open to the rush of air when the engine is running, and hence a constant stream of cold air is swept through them. The hot gases give up over one-half of their heat to this air-heater, and their temperature is reduced from 320 degrees Centigrade to 150 degrees Centigrade.

A simple locomotive depends for its furnace draft upon the rush of exhaust steam through the smokestack, and to compensate for this a fan driven by a steam turbine located just in front of the smokestack serves to produce the required draft.

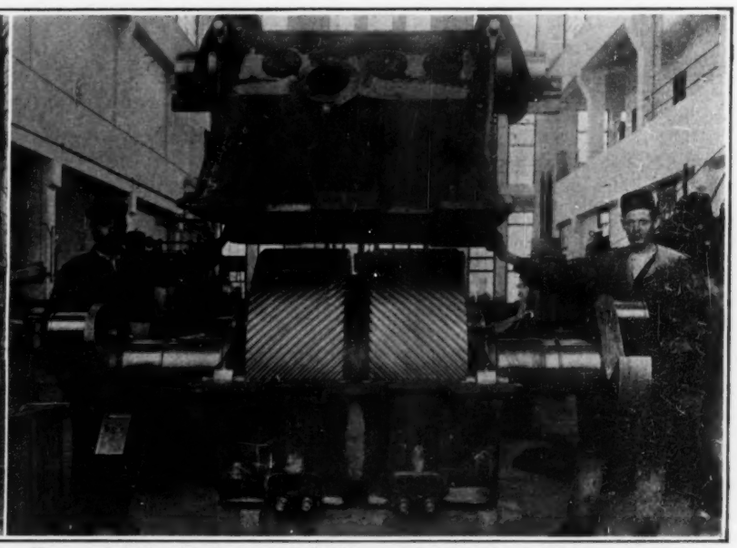
The hot air from the heater passes below the boiler, through a sheet iron conduit, and enters a closed ash pan below the fire grates. In order to reduce the draft when the fire doors are opened, the mechanism which opens the fire doors is connected to shutters at the front end of the air heater, and the connections are so arranged that when the fire doors are opened the shutters are closed, thereby preventing a back draft in the furnace.

The main turbine is carried at the front end of the tender or condenser, with its axis transverse to it. It is of the impulse reaction type, and is connected with a countershaft by means of a train of double-reduction, helical gears. At full speed of 68 miles per hour, which is the limit allowed by the Swedish government, the turbines run at 9200 r.p.m. and the driving wheels at

(Continued on page 142)



Front end of locomotive, with nest of tubes through which the air passes and is heated by the furnace gases on its way to the furnace



The crankshaft with the large helical gears of the double reduction gear. At 68 miles per hour, the turbine runs at 9200 r.p.m. and the crankshaft at 420 r.p.m.

Doubling New York's Water Supply

Two Additional Lines of 11-Foot Pipe Increase Aqueduct Capacity to 500,000,000 Gallons Per Day

UNDER the principle that the size of the neck of a bottle determines the rate at which it can be emptied, it may be said that the Board of Water Supply of the city of New York is just now engaged in the task of doubling the amount of drinking water which can be brought from the Catskills to New York City. This is being done by trebling the capacity of those sections of the 100-mile aqueduct, in which the water is conveyed through steel pipes. At present there is in such sections a single pipe, and the engineers are now engaged in laying two other pipes of equal capacity with the first.

The complete Catskill water supply project, as originally determined upon in 1905, called for the impounding of the waters of two streams in the Catskills —one known as Esopus Creek, which empties into the Hudson River, and the other Schoharie Creek, which heads on the opposite side of the divide and empties into the Mohawk River. To impound the water of Esopus Creek, the Ashokan Reservoir was constructed with a total capacity of 128,000,000,000 gallons, and the Schoharie water, which will be impounded in a reservoir of that name, which is now under construction, will store an additional 20,000,000,000 gallons.

Riveting up and caulking a stretch of one of the new pipe lines which are used in the crossing of valleys

The 5-ton sections of 11-foot steel pipe were transported from the factory to the pipe line by motor car

All but a few miles of the aqueduct leading from Ashokan to the northerly limits of New York City—a distance of 92 miles—is built either in tunnel or in cut-and-cover work. The cross section of the masonry aqueduct is of an approximate horseshoe shape, and measures 17 feet in width and 17 feet 6 inches in height. The aqueduct is built on a steadily descending grade, and this grade is such that the water flows as a river flows, by gravity, and at a predetermined rate of speed. This aqueduct is of sufficient size to carry a maximum daily supply of 500,000,000 gallons into New York City, which is the maximum dependable amount of water that can be drawn from Ashokan and Schoharie during a period of dry years.

In building the aqueduct it became necessary to cross various valleys and depressions, and instead of attempting to carry the aqueduct across these places at grade and therefore at high level, recourse was had to inverted syphons in the form of large steel pipes. To carry the maximum supply, three pipes of a diameter from 9 to over 11 feet are necessary; but the Board of Water Supply engineers decided to construct, at first, one pipe sufficient for a daily supply of 250,000,000 gallons, leaving the construction of the other two pipes to such time as the completion of the Schoharie dam, and the growing needs of the city should call for a daily supply of 500,000,000 gallons. That time is within sight, and consequently the board has let contracts for the completion of the steel syphons throughout the whole length of the aqueduct. Altogether, this process of trebling the number of pipes is being carried on at 14 different locations. The total length of new single pipe being laid is about 13 miles, and its total weight is 21,217 tons. When completed, the cost will have reached $6,253,000.

It will be understood that these huge pipes are among the largest, if not indeed the largest, ever built, for the inside diameter is 11 feet 3 inches. It was decided to build each ring of a single large plate, as shown in the photographs which accompany this article. The history of their construction, from the rolling mills to the final assembly and completion on the line of the aqueduct is unusually interesting. The plates for the particular pipe shown, which measures 7 feet 6 inches wide, center to center of rivets, 32 feet long between rivet centers, and from 7/16 to 9/16 inch in thickness, are rolled at Sparrows Point, Md., loaded into barges and brought to the fabricating works of the New York engineering concern on the banks of the Hudson River at Yonkers. Here they are cut to exact size by bevel shears, which leave them with what is known as a caulking edge. Then the plates are loaded into pickling tanks for the removal of scale and foreign matter. From the pickling tanks they are dipped into the fresh water of the Hudson River; and, finally they are given a lime bath, to kill any acid that may have been left on the plates. Next, the big sheets are loaded on to a traveling table, which carries them from the side of the dock into the fabricating shop, where 434 holes are drilled around the edges of each plate. The drilling is done by four drills, and the plates are packed six deep for this purpose. It takes from 4 to 4½ hours to do the drilling.

Hitherto, in steel pipe manufacture the common practice has been to bend the plates to the proper radius by passing them between three rolls; but the great size and weight of these plates, each of which weighs from over 2½ to nearly 3 tons, made it impossible to make use of rolls. Hence they are bent by passing them through a vertical pressing machine, the plate being laid on its long side and advanced 7 inches at each stroke. The pressing faces are vertical, one concave and the other convex, and each is curved to the proper radius for a 11 feet 3 inch pipe. The rings are then riveted, lap-riveting being used for the lighter pipe and butt-riveting for the heavier pipe. Two sections are riveted together so as to form one unit for shipment. The weight of each unit runs from 5 to 5½ tons. They are loaded on to 7½-ton truck and taken out to the Fort Hill and Bryn Mawr syphons, where the sections are riveted together into a continuous length.

To protect the steel, it is coated inside with 2 inches of cement mortar, and on the outside it is covered with 6 inches of concrete, the concrete being carried down on either side to form a general horseshoe, or inverted "U" section, the greater mass of concrete at the bottom corners and beneath the pipe serving to give it a massive and secure foundation.

It is interesting to note that the concreting is done with the pipe full of water and under full hydraulic pressure. This filling with water is necessary because the shape of the pipe when empty is different from what it is when full. In the full condition it sags, and the sides bulge out to a certain extent, the horizontal diameter being 3 inches greater than the vertical diameter when the pipe is empty. If it were concreted when empty the introduction of water under high pressure would tend to deform the pipe, and this movement would cause extensive cracking both of the inside cement lining and the outside concrete covering. The syphon at Bryn Mawr is under a head of 168 feet, and the total load on the bulkhead, which is to be built across the pipe, when it is water-filled, will be 529 tons.

The building of Schoharie Reservoir and the completion of the steel syphons will see the final completion of the New York water supply. Amid so much wasteful city work, this stands out as a noble monument to unhampered, non-political engineering efficiency.

Lightning's Pranks

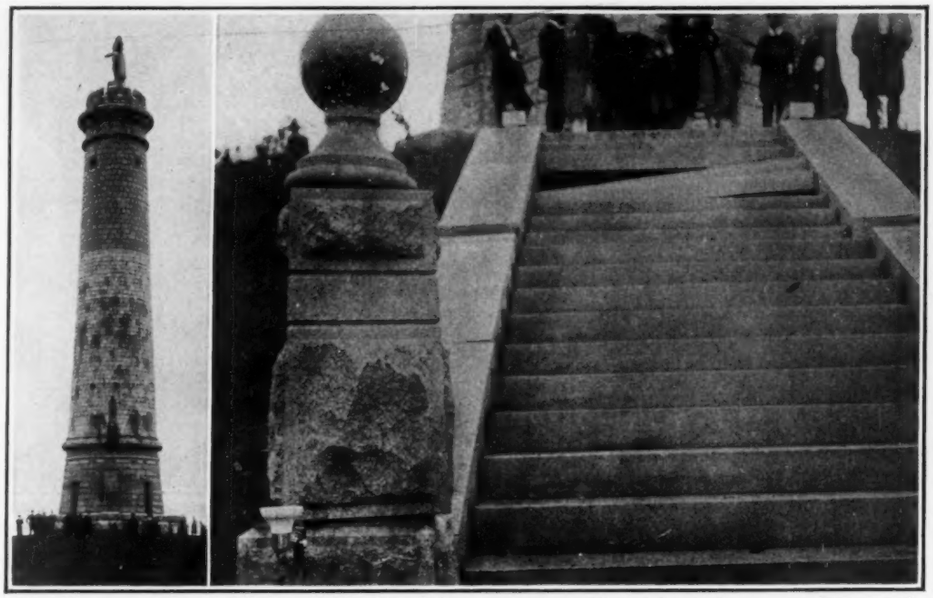
DURING an electric storm, on the afternoon of August 26, lightning hit the monument in memory of Capt. Myles Standish, standing on Captain's Hill, South Duxbury, Mass., and figured from the speed of high pressure electricity, took about one 186,000th of a second to do damage estimated at $10,000.

The site of the structure is on an eminence rising about 200 feet above the sea, and was once a portion of the farm of the military leader of the Pilgrims of the "Mayflower," who landed at Plymouth December 21, 1620, Capt. Standish locating in Duxbury some years after the establishment of the original colony. The monument rises nearly 120 feet above the base, is of granite and surmounted by a monolithic statue 14 feet high of Capt. Standish. The base is octagonal, 25 by 25 feet, and above this is the circular shaft with battlemented top, the whole surmounted by the effigy of Capt. Standish in ancient military garb, facing toward the open sea, with right hand extended, holding a rolled scroll in welcome to any who may come to these shores. The monument is hollow with a custodian's room in the base, a spiral iron staircase leading thence to the top, where there is an observation chamber with windows, just beneath the feet of the statue.

The lightning broke off the head of the figure at the neck, and tore away the left arm from the shoulder to the hand resting on the hilt of the sheathed sword. These fell on the upper deck of the shaft, the broad brimmed hat being broken in the tumble. A section of the heavy military cloak, nearly three feet long, was torn from the right shoulder to a point near the hip and this was thrown to the ground below. Apparently much of the cement in the upper section of the shaft was blown out and all of the windows save one near the lower portion on the northwestern side, were wrecked. The lightning seemed to have effected entrance to the observation chamber where tiling on the interior walls was thrown down. From that point the iron stairs probably acted as a conductor, for the next damage was in the custodian's room where tiling was torn away and glass in show cases smashed. The concrete walk from the entrance was ripped to pieces and the flight of granite steps leading up from the roadway damaged. At the top a large excavation was blasted in the earth nearly the full width of the steps and deep enough to hold a small automobile, minus the top. On one side the edge curbing and steps were separated nearly one inch and all of the cement blown across the flight, while at the bottom one of the stone pillars was twisted out of place as shown in one of the photographs. The little drinking fountain close at hand escaped harm. No one was injured, the custodian being away at luncheon and because of the heavy rain of that day, the ground keeper had not reported for duty.

The monument was begun in 1872 by the Myles Standish Monument Association, the corner-stone being laid October 7, that year. The project languished for some time and it was 1898 before the work was completed, dedication being made that year. It cost $40,000. Two years ago it was taken over by the Commonwealth of Massachusetts and is now a unit of the state park system. Each season thousands of tourists visit the spot in their pilgrimages to historic places. The monument is noted as a landmark for mariners in making this coast, it being very prominent from seaward.

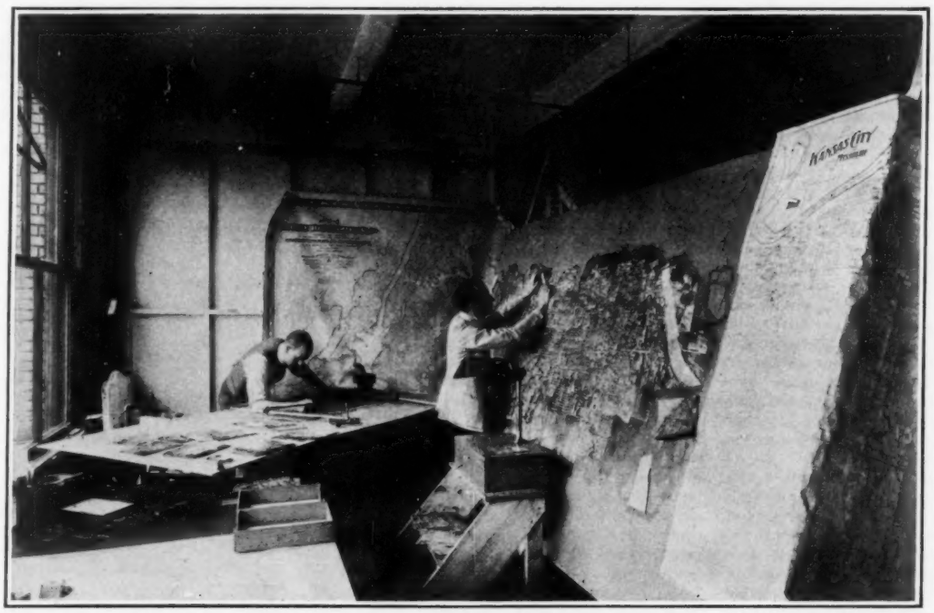
No provision for protection against lightning was ever made for the memorial, and electricians point out that the metal stairway was a serious menace, very much like putting a lightning conductor inside of a building.



The metallic stairway inside the Myles Standish monument at Plymouth acted as a conductor, and brought the lightning down to demolish the concrete walk and granite steps below. The monument as a whole is shown here, together with a close-up of some of the damage

Assembling an Aerial Survey

WHEN the city of Kansas City, Kan., ordered an aerial mosaic survey for the use of their city planning board and other city departments, they little realized the actual engineering knowledge and skill required in the completion of such a project. The accompanying illustration shows two of the aero-camera engineers assembling part of the 600 aerial photographs used in making this map. The board shown in the picture is securely screwed to a wooden frame, which for working purposes, is rested against a specially constructed easel. The control points for the laying of the map are plotted on the board from field notes made on the ground and from existing city maps on which the city engineer's notes have been plotted where accurate maps exist.



Bringing together into a single, connected whole the 600 separate exposures made in mapping a city from the air

These 600 negatives are sent into the dark room where a contact print is made from each. The contact prints are then assembled on a flat board to see that they cover the entire area included in the survey. Each contact print is then measured and compared with the known control points and a proper enlargement or reduction is computed. From these computations the enlarged or reduced print which is used in making the map is made up in the dark room, making proper allowance for paper shrinkage.

As all points on the ground are actually photographed three times in the making of the survey, the pictures are adapted to stereoscopic study. The stereoscope seen in the picture resting on top of the small ladder is an instrument developed by the French, which permits of far more rapid stereoscopic study than has been devised by any other country.

The assembled map when completed will measure approximately ten feet by six. Upon completion it will be copied or re-photographed on 15 or 16 copy negatives each approximately 20 by 24 inches in size. Prints from these large negatives will then be made (each showing several hundred feet of ground overlap), and mounted on linen to be used as an atlas or plat book.

The aerial photographers are at the present time employed on a variety of work embracing, as well as cities, forestry surveys, timber cruises, location of railroads, survey of existing railroads, survey of rivers for the development of hydro-electric power, tax and insurance maps, as well as many smaller contracts for industrial areas. Advices have recently reached this country that the city of Paris has been surveyed from the air at a scale of 200 feet to one inch. Over two hundred other French cities, principally in the devastated areas, have been surveyed from the air within the last three years.

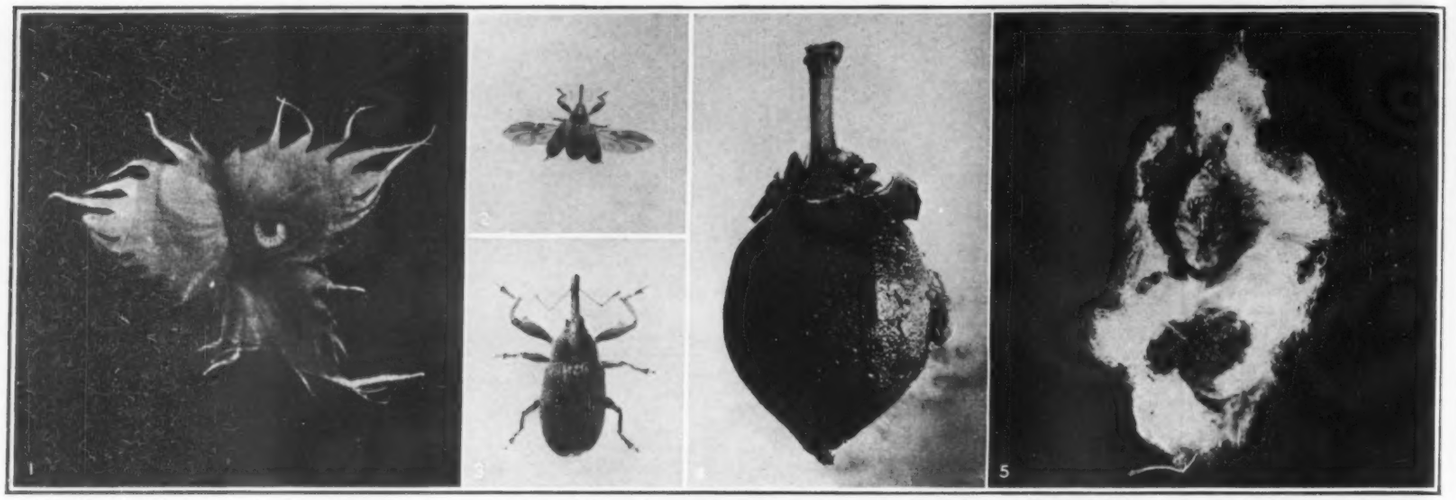
A Piezo-Electric Method for the Instantaneous Measurement of High Pressures

QUARTZ plates properly cut from quartz crystal liberates an electric charge when subjected to pressure. In order to measure the pressure developed in a gun during firing, a stack of these plates are placed in a small steel container in the form of a plug which is screwed into the breach block.

The charge which is liberated when the gun is fired passes through a special type of galvanometer and the galvanometer movements are photographed on a rapidly moving film. By means of the trace on the film, it is possible to determine the pressure at any time during the explosion, also the rate of combustion of the powder, the velocity the projectile would have if there were no friction, etc.

The device can also be used for measuring the impact or "force of blow" struck by hammers baseballs, boxing experts, rifle bullets, automobile bumpers, clock and watch escapements, etc.

This method of pressure measurement is described in Scientific Paper No. 445 of the Bureau of Standards, which will soon be ready for distribution from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy.



1. Larva in cotton "square," showing how the weevil does its greatest damage before it is a weevil, and while the boll is yet a bud. 2. The adult weevil with wings spread. 3. Adult weevil, magnified ten diameters. Note the stout snout with which it bores the hole in which to deposit its eggs. 4. Weevil on a cotton boll. Contrary to popular belief, it does not attack the boll, much preferring the tender "squares" or buds. 5. Pupa stage of the insect, just before emerging as an adult

The boll weevil and some of its deadly work

Getting Along With the Boll Weevil

Abandoning Hope of Suppressing this Pest, the South Considers the Problem of Its Control

By Harry A. Mount

THE COTTON boll weevil completed its conquest of the cotton belt in the United States in 1921. In that year 66,662 square miles of additional cotton territory was infested by the pest, and there remains uninfested only a little fringe of cotton producing land, containing only scattered plantings and producing only 5.4 per cent of our total cotton crop.

Furthermore, the boll weevil, over a total of more than 600,000 square miles of infested territory in this country, has been more active and more destructive in the past two years than at any period in the thirty years since the little beetle crossed the Rio Grande into Texas and began its steady, relentless conquest.

Entomologists and agriculturists who have been fighting the pest—all of these have given up hope that the boll weevil ever can be eliminated. Literally, the weevil has won its place in the sun and the pressing question no longer is, how we may be rid of it, but how can we get along with it?

IN 1892 the Mexican cotton boll weevil made its appearance in the United States, crossing the Rio Grande near Brownsville, Tex., and being found in the cotton fields of this vicinity. Without a set-back it has been extending its habitat ever since, until 1921 saw it established in all but 5.4 per cent of our cotton-growing territory. It has been necessary to give up all thought of exterminating it, by quarantines or other means; and to conduct the campaign against it on the assumption that it is here to stay, and that we may hope only to keep its ravages down to a minimum. Mr. Mount's article shows the present state of this work, and the hope that may be held out for the future.—THE EDITOR.

The advent of the boll weevil in the South has wrought an economic revolution. The old slip-shod farming methods no longer pay, and from force of sheer necessity the South is turning to scientific agriculture as the chief means of relief from its dilemma. The South is undergoing a great awakening, of tremendous significance, not only locally, but to the whole country and to the world.

There is a world panic in the industry using cotton as a raw material, for the South not only supplies all of the cotton needs of this country, but half of all the cotton used by the rest of the world. In no other spot are climatic, soil and economic conditions so favorable to the cheap production of cotton. A great association of English cotton mills is making desperate efforts and spending thousands of pounds in an effort to find another region from which they may draw a supply if the South should give up this important crop.

Egypt, India, South Africa, Brazil and Australia all produce some cotton, but an intensive study of these countries has forced the conclusion that they can never be a source of abundant cheap cotton.

Our Department of Agriculture has recognized the necessity for scientific diversified farming, but at the same time is urging strongly that cotton be retained as the "money crop" of the South. Cotton can still be produced at a profit over most of the infested area under methods of intensive culture and close control. Only in a few spots which are particularly favorable to the boll weevil has cotton culture been abandoned entirely. One such region is the coast of the Carolinas, where the famous sea island cotton has been grown. The weevil thrives particularly well there and so we now have to import a long staple Egyptian cotton to take the place of our once famous product.

In order to understand the nature of the situation which the boll weevil has brought about we ought to know some of the things which our scientists have learned about the bug in thirty years of study. It is not a native of the United States and had its first home probably in the plateau regions of Mexico or Central America. Before it appeared in the United States it had spread over much of Mexico.

In 1892 a small area of cotton fields in the neighborhood of Brownsville, Texas, was discovered to be infested with the weevils. Dr. L. O. Howard, now Chief of the United States Bureau of Entomology, who was then in the employ of the State of Texas, made an investigation and at once recognized the destructive possibilities of the insect. He prepared legislation which was introduced in the State Legislature providing for a quarantine of the infected area. The bill was laughed at and pigeonholed and the final chance of ever checking the boll weevil in the United States was lost.

The very next year the area infested was quadrupled and from that time until the present the area of destruction has been steadily extended, until now practically the whole cotton belt is infested.

It may seem strange to the average layman that in all these years, during which hundreds of scientists have been engaged in the fight on the weevil, no method of extermination has been found. The explanation is that it is not the adult weevil which does the damage, but the larvae which hatch from the beetle's eggs. The beetle chews a hole into the young cotton "squares" or buds and deposits the eggs deep inside. The cotton plant itself heals over the wound with a gummy secretion that makes an effective seal over the eggs. The egg develops and the young weevil is born and thrives in a sealed compartment, where he is perfectly safe from any amount of poison.

It is possible to reduce the damage to some extent by spraying the plants with poison at the time the adults are laying their eggs. But the weevil has enormous recuperative powers, and although only a few beetles may survive the poison brigade, they produce enough offspring to repopulate the field with their kind. The possible production of offspring from a single pair of weevils in one season is estimated at 12,755,100. But nature has provided enemies which prevent such excessive multiplication. Chief among these are heat and cold and other insects which prey upon the weevil. Only from 2 to 11 per cent of the adult insects ordinarily survive the winter season, but these few survivors are quite sufficient to retain full possession of a field, and even to extend their domain.

Natural control agencies vary greatly in effectiveness from season to season and from field to field, and this introduces an element of uncertainty in cotton growing which is most discouraging to the farmer. This much is sure: once infected a field will remain infected as long as cotton is grown there.

Almost countless methods of control have been suggested and tried, but all except one have been discarded as useless. Dusting with powdered arsenate of lead after the "squares" have become about 10 per cent infected effects sufficient control to more than pay for the cost—provided the yield of the field is naturally large. It is generally true that it no longer pays to raise cotton on land which normally produces less than a half bale of cotton per acre. Scientific methods of fertilization are, therefore, a first necessity.

The weevil itself is from a quarter to a third of an inch long, and from light brown to gray or black in color, depending on age. About a third of its length is taken up by a stout snout. The insect passes the winter in the adult stage, taking no food and remaining practically dormant. The beetles emerge from their hibernation from March to June and begin their life work—reproduction. The eggs inside the cotton "squares" hatch in about three weeks and the grub immediately begins to gorge itself on the tender leaves of the immature bloom. In from seven to twelve days the larvae pass to the pupa stage (corresponding to the cocoon of the butterfly) and in from three to five days more the adult issues and the process is repeated. The average adult life is about fifty days in summer.

As soon as cold weather approaches the weevils begin to hunt winter quarters and they fly away from the

field in every direction. But the weevil is a weak flyer and he is usually carried with the prevailing winds. Thus the weevil extended his reign eastward much faster than northward or westward. In fact the weevil infested cotton fields on the Atlantic seaboard before he reached fields in the northern and western part of Texas, only a few hundred miles from the place of entry into the United States.

The total annual damage of the insect is conservatively estimated to exceed $8,000,000, while the total damage done by the boll weevil in this country is thought to be between $200,000,000 and $300,000,000. But in spite of the rather hopeless aspect of this situation the United States is still by far the greatest cotton producing region in the world, and that leadership will no doubt be maintained. What the South has lost through the boll weevil it has more than recovered by better farming methods.

The fact that successful cotton raising now requires intensive culture reduces the acreage required to produce a given amount of cotton. This has released land formerly used for cotton for other crops and in many cases has resulted into breaking up the large plantations into smaller farms.

This turning to diversified farming, as against the old single crop system, has secured for the South a degree of economic independence heretofore unknown. The average Southern family living on a farm in the "good old days" actually had to buy a great deal of the family food which could have been raised there, and nearly all of the food for horses and mules.

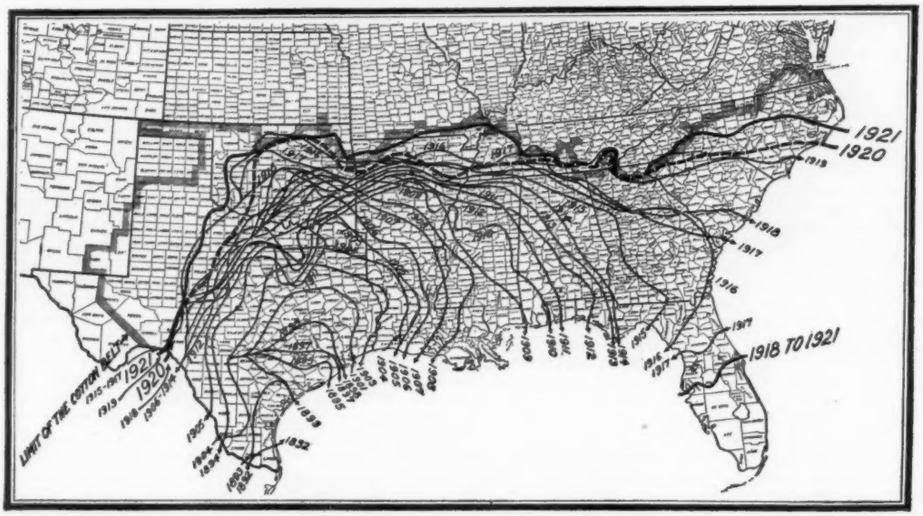
Unfortunately the South cannot compete with other sections in raising such staple crops as corn and wheat. But sweet potatoes and peanuts are typical Southern crops of growing importance, and rice culture is coming to be a great Southern industry. Besides this the growing of sugar cane is profitable in many sections and market gardening to supply both the cities of the South and the northern centers of population can be carried on practically the year round. Southern melons, fruits and berries are already famous in Northern markets.

The productivity of Southern soil planted in vegetables may be judged by these instances authenticated by an investigator for the Department of Agriculture:

At Cliffside, N. C., a garden of three-fourths of an acre, tended at odd times by a family of four, with an expense of $5 for preparation of the soil and $2 for seeds, raised eleven kinds of vegetables with a market value of $97.65. A workman, at Charlotte, N. C., on five-eighths of an acre at a total expense of 15 cents for seed (he had saved his seed from the year before), raised dry beans, cabbage, turnips, peas, onions, beets, cucumbers, tomatoes, sweet corn, and peppers in one season with a market value of $92. An investigation of 950 Southern farms showed that the home garden now yields food for the family at a value of about $94 a year, a great part of which formerly was purchased.

The Southern market gardener has the advantage over his Northern competitor (who now supplies the bulk of the market produce in a long growing season) in a short mild winter, and no need for expensive equipment to keep winter vegetables. Almost all of the market vegetables grown in the North will thrive also in the South and a number of these can be grown which cannot be raised elsewhere. The development of direct refrigerator car routes to the centers of population solves the heretofore serious problem of getting this produce to market in good condition.

Cotton bales awaiting shipment at a Texas rail-head



Map showing dispersion of the cotton boll weevil in the United States, from its introduction from Mexico in 1892 to its final spread throughout the cotton states in 1921. The heavily shaded band represents the limit of cotton cultivation

This turning to diversified, scientific farming as a result of the boll weevil's depredations has so greatly improved the condition of many Southern communities that the expression is frequently heard that the boll weevil has been a blessing. Actually, one Southern town has erected a monument to the boll weevil because of the awakening which has taken place in that vicinity.

Undoubtedly also the boll weevil has been instrumental in the great industrial progress of the South in the past few years. Negroes who have lived on small patches of land, producing little more than enough for their own sustenance, are moving to the cities and they make up the last great reservoir of cheap labor in this country.

However undesirable this may be from a sociological point of view, it has the effect of attracting industry. This industrial development has awakened the South to its great natural resources, and these are being rapidly developed. In the South are 62,000 square miles of bituminous coal lands, more than in England, Germany, France and Austria combined. There are more deposits of iron ore than in all Europe. The South is producing about half of the world's sulfur supply. It has the only important known deposits of phosphate rock, the foundation of a great fertilizer industry. It has over 40 per cent of all the standing timber in the United States. In addition to this it has great, almost untouched, deposits of marbles, granites, clays and building stone unsurpassed anywhere else in this country.

All this may appear to be going rather far afield from the subject of the boll weevil, but it helps to explain how, in the face of what is considered by many the greatest calamity ever suffered by an agricultural section, the South is steadily meeting the world's demand for cotton and at the same time is consolidating her economic position in such a way that another such calamity can probably never occur again.

Dusting cotton with arsenate of lead, a method which is only partially effective, though the best known

Musical Broadcasting Experiments

IT is not always that the public benefits with experimental work, but in the case of the radio development in broadcasting music at Anacostia, naval radio experts are letting the public in. Every few evenings, from 8:30 to 9:30, the Marine Band plays for entertainment on 412 meters sent out by NOF, and it is all part of development work.

The broadcasting of speeches and music from a large room has met with difficulty, due to distortion, reverberation and the inclusion of outside noises; even the most successful transmission of music shows considerable distortion, according to naval experts, but the music is nevertheless received and enjoyed by 90 per cent of the receiving stations. The difficulty is in securing an accoustically perfect room for transmission. At Anacostia this is accomplished by enclosing part of the room used so as to make a 15-foot square studio. It is enclosed in loosely-hung curtains of airplane cloth, which deadens all sounds and echoes.

A large number of letters received since the band has played have commended the work and offered some valuable criticisms. Solos and duets go best, it is said. During a quite recent evening, a selected orchestra of 12 pieces played with good results, judging from the letters received by the band leader and radio operator. The drum has been eliminated, but a means of successfully muffling it may be found. Brasses, it is found, reverberate more than string instruments. The violin carries the best of the instruments experimented with, while the reproduction of the piano is found to be difficult; the harp was excellent.

By using recently-developed microphones, improvements are expected. Better results can be had by using high and low pass filters, which ought to be used in the microphone circuits in addition to the stretched diaphragm microphones, with their periods well out of the range of ordinary audibility. The NOF radio telephone station is sufficiently powerful to cover a large section of the country, and entertains tens of thousands.

Taking the Menace Out of Dust

Life and Property Saved and Safeguarded by the Use of the Vacuum Cleaner in Industry

By F. C. Allen, Jr.

SATURDAY afternoon, March 19, 1921, was the date of an explosion which wrecked the Chicago and Northwestern grain elevator in Chicago, killing six men and causing a property damage of about $3,750,000. The shock was felt fifty miles away, and the detonation was heard for a hundred miles.

No bomb was set off, nor incendiary outrage perpetrated. No anarchist or Bolshevist was responsible for this destruction. The material which exploded was not a commercial or military disruptive at all, but ordinary dust, such as prevails in every place where grain is handled, and in many other industries. These dust explosions have occurred with such frequency and have caused such damage that the Federal Bureau of Chemistry has for many years been making a study of their causes and the means for their prevention.

To the layman it seems inconceivable that grain dust can explode with such violence as to burst heavily reinforced concrete structures, or to cause such damage as is shown in our second photograph. Indeed, many of us would perhaps be inclined to dispute the assertion that grain dust was explosive at all, if this assertion came from a lay source. The fact seems to be, however, that almost any dust whatever, if it be fine enough and if it be ignited effectively by electric spark or other means, will explode, and explode with great violence.

Extensive research has shown that in destructive dust explosions there are (at least) two separate and distinct detonations. In the Chicago disaster cited above, these came about ten seconds apart. The explanation is that, in a building of this character, the dust which escapes from the various operations of handling the grain floats around in the atmosphere until it finally settles on interior surfaces such as floors, walls, rafters, overhead pipes, etc. At any moment there is a reasonable amount of "suspended dust" in the atmosphere itself, and a much greater amount of "static dust" on these surfaces. The initial or primary explosion takes place when the suspended dust is by any means ignited; and this explosion would hardly do more than slight local damage, of itself. But the concussion from the primary explosion agitates and jars loose the static dust all over the building; and if the short circuit, overheating, etc., which caused the primary explosion is still operating, or if the temperature from the primary detonation be sufficient, the heavy secondary explosion follows. This is generally of great force, and is the one that does the damage. Sometimes there will be a series of secondary explosions in different parts of the building. A primary explosion of the suspended dust is seldom serious of itself, unless followed by secondary explosion or by outright fire.

It is obvious enough that in the handling of material like grain, coal, etc., no very successful effort can be made to prevent dust formation, or even to prevent the dust that forms from escaping into the atmosphere. The problem of just how to prevent the explosion, after the dust has formed and escaped, is one of interest to numerous industries; for many kinds of dust have been definitely shown to be explosive, which were not formerly so regarded, and it seems quite possible that all dusts will explode if fine enough. Among the surprising dust explosions which have had fatal results were those of aluminum dust and the dust from hard rubber.

The dust itself being unavoidable, the problem is reduced to that of determining the best method for collecting and removing the dust which escapes. Obviously it must be confined and prevented from escaping to the greatest possible degree, and this is today being done in the dusty industries. Obviously again, it cannot be prevented from escaping altogether, so it will be necessary to collect it as quickly as possible after it does escape into the atmosphere. This again is being done, by means of huge suction fans connected with large exhaust ducts that lead to collecting bins. Sometimes the salvaged dust even has a value.

Cleaning "static dust" from floors and walls with a giant vacuum cleaner, thereby preventing the more serious dust explosions

But even with these precautions it has been found impossible to collect all the dust that forms. With any system, much dust is still found to settle on the interior surfaces, and the collection of this static dust introduces a new problem. Sweeping or brushing, which is only moderately effective with the relatively large and heavy dust particles of the household, is out of the question with this extremely fine industrial dust. Compressed air blasts for dislodging the dust preparatory to catching it again in the atmospheric exhausters are open to the same objection—a means is sought, not of stirring up the dust and moving it to another spot, but of gathering it up and removing it from the building. In some industries, the floors and walls can be dampened for sweeping; but not in a grain elevator, where it would be next to impossible to dry them off again, while the presence of the moisture would rot any grain placed in the room affected.

The reconstructed Chicago and Northwestern elevator has been fitted with a dust-remover system that is now being developed by a Boston engineering firm. Briefly it is a vacuum cleaner on a very large scale; and it is highly successful. Inasmuch as the present is the largest installation yet made, we may assume that it also represents the world's largest vacuum-cleaner. In fact, though it admittedly operates on the same principle as the smallest household suction-sweeper, its power, size and capacity are so very much greater that its manufacturers prefer to discriminate, and to call it a pneumatic sweeper.

By this means the dust is quickly and thoroughly cleaned from floors, walls and other interior surfaces, and is conveyed through the flexible hose and the piping system to the dust collectors of enormous size, from which it is automatically dumped into a low-pressure-air conveying system, which takes it to the dust house located at some distance from the main buildings. Apparently this is the logical and practical solution of this important problem of industrial housekeeping.

The great feature of the process is that absolutely no dust is raised during the sweeping, all dust coming within range of the nozzle being automatically sucked in and carried away. Floors and other surfaces are cleaned so thoroughly that they have the appearance of having been scrubbed with water, whereas the ordinary sweeping process leaves a coating of dust which is far from microscopic. The point is well illustrated in our first photograph, where the "swept" surface is distinctly of a different hue from the unswept. The suction of the pneumatic sweeper is operative on both forward and back strokes, which is not the case with the broom. The powerful suction dislodges dust from cracks, corners, etc., into which no strictly mechanical implement can penetrate.

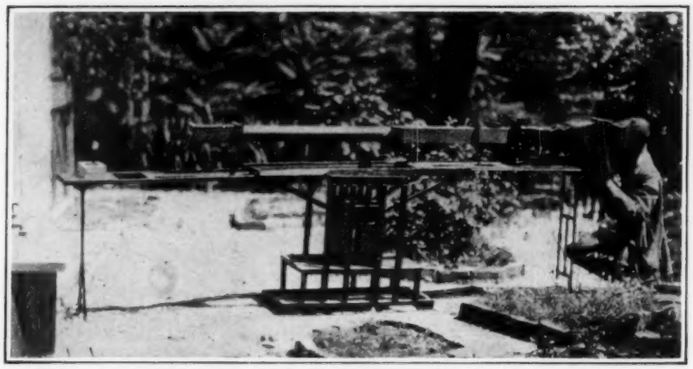
This was the damage done to a concrete-and-steel grain elevator by a dust explosion, against which the new technique of the pneumatic sweeper is directed

In view of the enormous volume of dust handled, the problem of its immediate disposition was a serious one. The largest possible collector of the ordinary vacuum-cleaner type would be filled in 30 minutes or less. It was accordingly necessary to install dust collectors equipped with continuously operating discharge mechanism. This mechanism is called a "lock," since it must work to discharge the dust from the collector without admitting outside air to destroy the high degree of vacuum maintained within the tank.

Making Big Photographs of Little Things

By Dr. E. Bade

PHOTOGRAPHY has become an important factor as an illustrator of the written word, and in trained hands it gives perfect pictures which are absolutely accurate to their last detail. Just as important as general photography is photo-micrography, which cannot be approximated through drawings when the microscopic slide has been prepared with technically perfect skill. But these two types of photography are not sufficient for the illustrator. Photo-micrography provides us with pictures of a minute and obscure world hidden from the human eye, while general photography gives us pictures of larger things on a smaller scale. Between both these extremes lies a world of tiny, just perceptible objects, which show their beautiful and detailed structure under a hand lens. This gap is bridged by the little known and still less appreciated "macrophotographic" camera.



The macrophotographic camera fully extended to 12 feet, for greatest magnification

Larger photo-micrograph objects, which are still too small for the ordinary camera, can only be taken in fragments with the lowest power of the microscope, followed by combining all of the many separate parts. But a perfect slide must be available for such a purpose. Photographs from species of flies or other small insects, enlargements of tiny flowers, textile products, and hundreds of other objects which only require an enlargement of ten to twelve diameters, are best taken with the macrophotographic camera.

For this purpose the object must first be prepared. If it is an animal, it must be killed and spread, but the resultant photo will be of exceptional value in regard to detail and depth, which are not to be seen in the best photo-micrographs. But the preparation of the animals for the camera is difficult since it presupposes a knowledge of the life and habit of the animal in question; also, the technique necessary must first be mastered. As a rule the animal must be prepared under the magnifying glass, and the extremities and appendages must be placed and dried in their natural position before they can be photographed.

Excellent macrophotos showing all the requisite details can easily be made, especially if the objects have been prepared as microscopic slides and imbedded in Canada balsam. Then the subject is so placed that it is illuminated from the back, and between it and the source of light is placed a piece of ground glass. By this means the mosaic assembly of the various photo-micrographs is eliminated, since the entire subject is photographed at one time on a suitable sized negative.

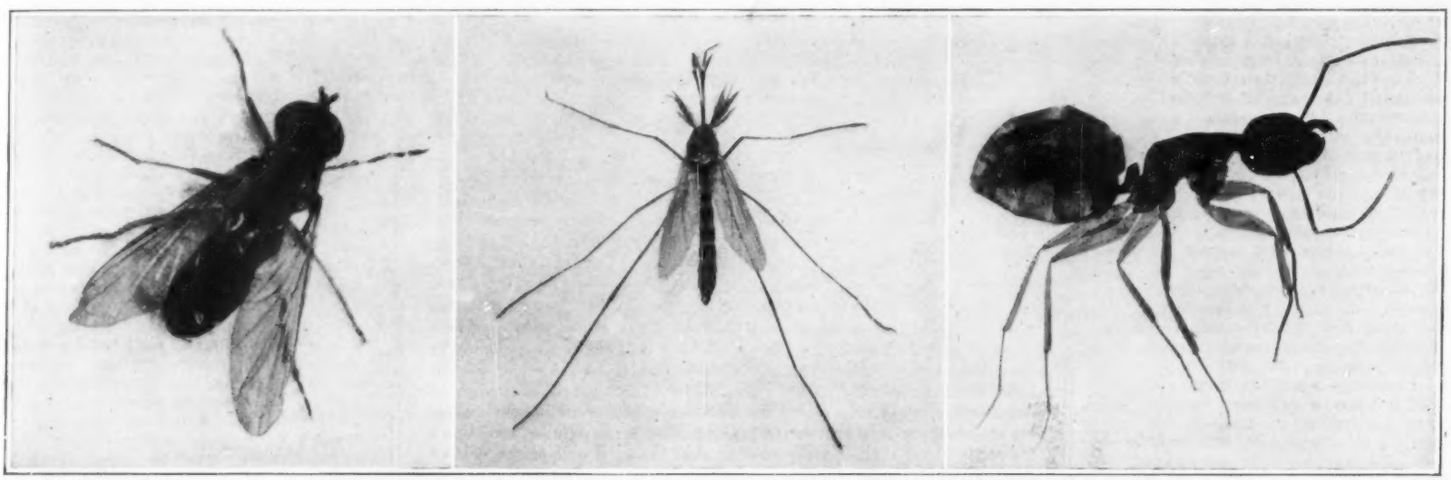
The camera itself has a double-extension bellows together with numerous tubes. With this arrangement any desired magnification becomes possible, although enlargements of more than twelve diameters are unsatisfactory, since they give cloudy and foggy plates. Only a fraction of the light then passing through the lens reaches the film, and in addition, few of the details and but little depth of focus will result. From this point, therefore, the microscope must again be employed.

Each of the tube sections used must have an internal diameter at least one-third larger than the diameter of the lens, and if possible each tube should be made larger. When tubes of a smaller diameter are used, the plates will not be completely filled with the image of the object, and this limits the usefulness of the camera unnecessarily. It is also advantageous to have various lengths of tubing, each length corresponding to a certain definite, later to be established, magnification. Then it is a comparatively simple matter to insert any number of lengths necessary. When all sections are used, the greatest magnification will be attained, while any of the intermediate ones will give correspondingly lower magnifications.

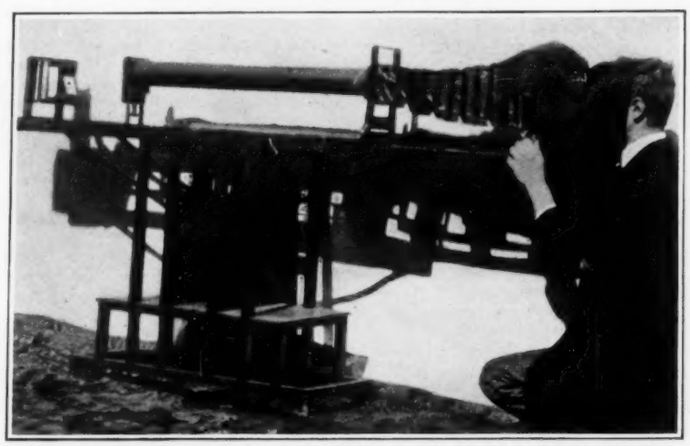
The smaller sections of tubing should either be one-half or one foot long, and it is best to have two of each. The other sections are two, three and four feet in length, and this, together with the double-extension bellows of the camera proper, should give an over-all length of about ten to twelve feet, although this must depend upon the type of lens available. With a short focus, smaller extensions can be used, but with a long-focus lens, a comparatively long extension will be necessary. Each section must be made absolutely light-tight, and it must be blackened on the inside. This is best accomplished with a coating of dull black paper. Care must also be exercised that the joints connecting the various sections are light-tight. If the slightest amount of light filters through any of the joints, no results can be expected. In addition, each section must be properly supported by some suitable means. A discarded toy railroad track is ideal for this purpose, the tiny wheels being attached at the ends of the different sections so that they readily slide among the track, in moving the lens nearer or farther away from the subject. If the arrangement tends to be rigid, then the subject must be moved while the lens remains fixed.

The image of the subject is first brought to a focus upon the ground glass. When it is in the right position, the glass is removed, and the object is brought to a sharp focus by means of a small hand lens or reading glass. Here it must be observed that the focus of this small lens must lie in the same plane as the removed ground glass. When the detail of the object nearest to the lens of the camera is sharpest, the iris diaphragm of the lens is closed down sufficiently to bring the details farthest from the lens into focus.

Then, after closing the shutter, the subject is ready to be photographed. The exposure naturally varies with the magnification sought, the opening of the lens diaphragm, and the light conditions at the time. But good results can only be obtained with the high-grade lenses now available, and a double anastigmat lens of fairly wide aperture is an essential prerequisite in work of this nature. With a good lens the photographs obtained will be so sharp, distinct and perfect that, if they are taken in direct sunlight on a 4 by 5 inch plate or film, they can readily be enlarged with the ordinary enlarging camera without losing any of the details. The accompanying illustrations show the set-up of the macrophotographic camera and some of the work which can be turned out with it.



Three macrophotographs made by the author with the apparatus described in the accompanying article. The first photograph is that of a fly, Mesogramma Parvula; the second, a mosquito; the third, a macrophotograph of a microscopic slide of an ant



The macrophotographic camera slightly extended for lower magnification

Specifications for Biological Glass

THE Bureau of Standards is collecting information from the Army, Navy, the Biological Survey, the Public Health Service, and manufacturers of biological products concerning the requirements of glass for this purpose and the desirability of preparing standard specifications covering the same. The Bureau has already assisted manufacturers of biological products in obtaining glass suitable for their use, but the requests have indicated a possible value for more complete specifications.

The New Conservation—III

The Savings of Simplified Practice, and the Universal Benefits Resulting Therefrom

By Ray M. Hudson

Division of Simplified Practice, Department of Commerce

WHEN August Heinz first presented his "57 Varieties" of his justly famous pickles to the public, he made a big hit with the grocers. They were no longer forced to rack their brains when suggesting substitutes in case the customer could not be given what she wanted. Instead it was an easy matter to call her attention to the other 56 and let the subtle psychology of that variety do the rest. That was good sound business.

But consider the same principle applied to plows. Consider that before the war, steel plows were offered in 312 different types and sizes. Automobile tires, in those days, were purchasable in 287 styles and sizes. Washing machines were made in 446 types and sizes, and pocket knife catalogs listed nearly 6000 different patterns. Fortunately, Mr. Heinz was limited by the natural variety in the vegetable bases of his products. Nevertheless, that limitation was his good fortune for it required his cooks and chemists to concentrate on quality rather than quantity.

More than one manufacturer today wishes some such natural limit might be imposed on his engineers, designers and draftsmen. Quantity, expressed by too great a variety, may easily become a liability instead of an asset. That is easy to understand when you think that some of the 312 different plows, or 446 types and sizes of washing machines, were in much greater demand than others. In fact, the manufacturers' own war service committees in cooperation with the conservation division of the War Industries Board found they could satisfy the bulk of their trade requirements with 76 types and sizes of plows, 32 of tires, 18 of washing machines and not over 100 of pocket knives.

This reduction in variety, inspired by patriotic motives, was maintained after the war by several of the manufacturers simply because they found it paid. To them, a simplified line, one composed of those patterns and sizes in greatest demand and therefore in most common use, meant less capital tied up in raw material, in work-in-process, and in finished stock. Keeping down the work-in-process account is one of the major tasks of factory managers. It seems to grow without rhyme or reason, and the more varied are the products and the greater their individual complexity—the more difficult is the control of the capital invested in work enroute through the shops. It takes much effort, both human and mechanical, to keep such a huge mass of material in motion, and if you will take pains to look at the stock in the tote-boxes lying around the machines the next time you go through a large shop and note the signs of long tenure of their individual location, you can form your own conclusions as to how fast the money tied up in them is being "turned over." The more alert managers watch this closely and continually seek to expedite the flow of work by shortened routings, more accurate scheduling and more prompt dispatching of work from machine to machine.

With parts designed for maximum interchangeability, and with greater uniformity in design in the various products comes a decrease in jig, die, tool and special machinery expenses. Investment in these costly accessories of manufacturing is reduced, and the expense of upkeep for those in use is likewise lowered.

Parts are sent through in larger lots or batches, giving the mechanics longer runs, and requiring fewer changes in the set-ups, or processes of making ready, to do the particular operation required on the part. These things in turn serve to increase the worker's output per day. There is less waste, less lost motion, and less misdirected effort. Simplification makes for factory economy; over-diversification breeds loss to the workers themselves—a standardized line means greater stability of employment. When the management believes in simplification it is not afraid to authorize production of the articles comprising the cream of the line—for those made in the dull season of sales form the reserve supply from which shipments are drawn in the period of maximum demand when the factory capacity will not permit sufficient output to equal that demand. In other words, the factory force swings along at the same steady stride month in and month out and the seasonal fluctuations in the trade never seep back through the shipping room into the shops. Men become more expert in their respective jobs, quality of workmanship improves, and product quality is thereby raised, while the workers become more valuable to their employers by reason of the greater skill acquired. Correspondingly, the man at the machine increases his own earning capacity, for as costs go down under his skilled manipulation of his machine, it becomes possible to return to him in his wage envelope a fair proportion of the savings he has made. When the economies of simplification are carried through in the form of lower prices to the consumer, the same worker again benefits through the increased purchasing power of his dollar.

Production, expressed as the economic process of preparing goods in forms that will satisfy human wants, is facilitated by the recognition of this principle through all stages in the process of converting raw material whether iron ore, raw cotton, or crude rubber, or any other material, into finished articles which we can apply to a specific purpose. Even if the advantages of simplification ended there, it would be well worth adoption, but it does not stop with the piling up of goods in the factory warehouse. Now that we have the goods that will satisfy some need or want, what will we do with them? Obviously, we must "tell the world." Advertising campaigns are launched on a national scale; salesmen by the score take to the road. Potential consumers call at the local stores and soon the merchants and the manufacturer's salesmen have completed the contact between the thing made and the man who wants it. Distribution is the odd triplet. His brothers, Production and Consumption, have kept along at a right smart pace, but Distribution is always a lap behind. Too much in one place, not enough in another, merchants overstocked on some lines, and sold out on others, and yet the costs of doing business, including the rent, heat, light, repairs, clerk-hire and all the others, keep right on. Merchandising, described as the science of bringing the consumer and the goods to the right amount together at the right time, is full of pitfalls for the unwary. It is not at all difficult for the storekeeper to tie up 75 per cent of his capital in lines that do not yield him 25 per cent of annual volume of business, thus leaving the other 25 per cent to buy the goods that constitute 75 per cent of his yearly sales.

Staple lines, easy to buy, quick to sell, keep moving—for they are live lines. Clearance sales offering large quantities of certain goods are not always what they seem. Many times they are "confessions" that the buyer for the house spread his purchases too thin, or picked too many lines, and thus overstocked his shelves. And why? Mainly because of one of the most fallacious beliefs ever known, but none the less common to many distributors, "that to stay in business, you always have to give the customer exactly what he asks for." The average consumer is not so keen about having his own way in his purchases as he may appear at first glance. What he wants is value—the maximum useful return for the least expenditure. He knows that many of the things he buys today would be unobtainable at the prices they command, were it not for the fact that they are made under highly standardized conditions in scientifically managed plants, and sold in large quantities by live, aggressive merchants who accurately anticipate demand, and use good sense in stocking up to meet it. By concentration on fewer lines, turn-over is quickened, selling effort and expense is lowered, the sales force becomes more effective, and greater volume of business is done. The dependability of nationally advertised standardized goods is their major talking point.

If we magnify these elementary examples, and consider them in their relation to foreign trade, we find the same basic truths apply. Manufacturers in other countries have long been noted for their peculiar adherence to their customer's wishes. Consequently, mass-production has not become a part of their national vocabulary as it has in ours. But in the present efforts of other nations to rehabilitate their industries, we can observe many evidences of an awakened interest in simplification. A case in point is related by the American Engineering Standards Committee in a recent bulletin:

"Nineteen German manufacturers and one Swedish manufacturer are now working on an order for seven hundred locomotives, all of the same design, for Russia. Every part in every one of them is being made interchangeable with the corresponding part in all the others. This feature will have the great advantage of permitting the Russian railroads to use any disabled locomotive as a store of spare parts for any others. In one case, a locomotive was assembled, from parts machined in twenty different shops, with no more difficulty than if it had been built complete in one shop."

Since our own domestic market takes nearly 80 per cent of our manufactured products, we have here at home a larger opportunity to apply simplification than any other country has within its boundaries. Our export market, approximately equalling the remaining 20 per cent of our output, is benefited by standardization, for it is in such lines as typewriters, agricultural machinery and automobiles, representing the broadest application of this principle, that we find the larger part of our fabricated exports.

With national standardizing bodies actively working in Austria, Belgium, Czechoslovakia, France, Germany, Great Britain, Holland, Italy, Norway, Sweden and Switzerland, also in Japan and Canada, we may soon find our efforts to gain a better foothold in foreign markets nullified by this concerted action of overseas manufacturers to increase the salability of their own products through simplifying their lines.

But American goods can be and are sold abroad under conditions existing there, as our own Bureau of Foreign and Domestic Commerce will tell you, because of their better quality and greater utility. The relatively higher price asked for them in comparison with the prices of the foreign manufacturers is no criterion of the vastly greater value given in proportion thereto. Consumers abroad are no different from those at home in their fundamental conceptions. Trade knows no boundaries, either political, religious, or otherwise. If simplification is helpful to America, it is to England, Germany or Japan. For the past 40 years the United States has been the workshop of the world. Great natural resources, versatile and ingenious labor, and a higher standard of living have all had a part in giving us a lead over all other countries in manufacturing capacity, technique, and output. But as the fabled tortoise passed the sleeping hare, so may we find that lead cut down by the very rapid strides our foreign competitors are making in the simplification and standardization of their products. When, through applying this principle to the production and distribution of commodities of universal demand, their quality is improved, and their costs lowered, the drift of the buyer's dollar, or peso, or yen, will be toward the country where the best values are offered.

If we would maintain our present position in the

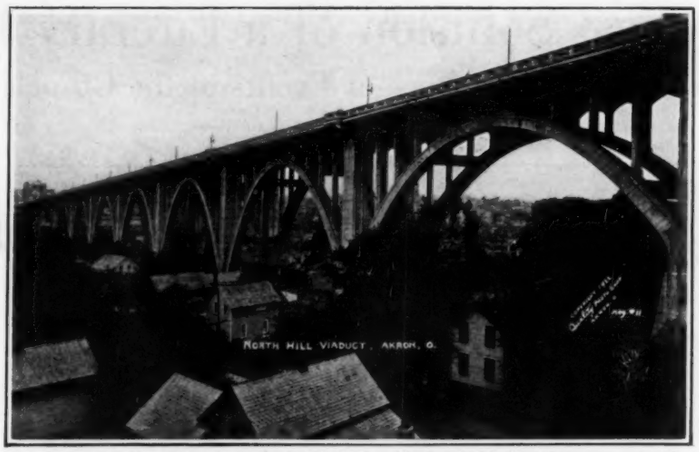
(Continued on page 143)

BY FAR the majority of the retail failures are due to undercapitalization. By far the majority of manufacturing failures are due to unseen and uncounted costs that are not passed along to the consumer. And for all failures the ultimate consumer pays. Mr. Hudson has already explained sufficiently what he means by standardization of product and contraction of variety in the output of the individual factory and of each trade. The thing has been shown to be feasible, from the consumer's viewpoint; we really don't need 6000 different models from which to select a pocket-knife, or 446 from which to choose the new washing machine. What simplification of the manufacturer's catalog means in the way of financial relief to him, to the retailer, and hence indirectly to the user, is made clear in this, the third and final article of Mr. Hudson's series.—THE EDITOR.

Completion of a Notable Concrete Viaduct

THE formal opening on October 12, 1922, of the handsome North Hill viaduct at Akron, Ohio, marks the completion of one more of those graceful steel and concrete viaducts and bridges which are proving so indispensable to the development of the railroad and highway system of the country.

As between steel and masonry as the material of construction, there can be no question that, for bridges up to a certain magnitude, masonry, on the score of beauty and permanency, is greatly to be preferred. Not only does it cost less at the first construction, but masonry—under which concrete, of course, is included—has the great advantage that there are practically no subsequent costs for maintenance. A steel bridge must be periodically inspected and painted, otherwise it will rust out and disappear, and painting, in the case of a large bridge, is a serious and costly problem. Masonry, on the other hand, is not only permanent, but in coloring and appearance it improves with age.



The graceful North Hill viaduct, 72 feet wide by 2810 feet long, a recently completed crossing of the Cuyahoga Valley

The North Hill viaduct, as it is called, bridges the Cuyahoga Valley, and not only provides a service for the thickly populated North Hill district, but will result in a saving of time on the Akron-Bedford-Cleveland Division, and the Akron-Kent-Ravenna Division. The viaduct is 72 feet wide and 2810 feet long. Of the width, 52 feet is given up to the roadway, and there is a sidewalk on each side 10 feet wide. The structure consists of 16 main arches and 13 narrower arches. The average width of the main spans is 150 feet, the largest measuring 191 feet in the clear. The piers are founded upon concrete piles sunk to an average depth of 38 feet below ground level, and 2731 piles were sunk, representing a total length of 101,000 feet. The main piers measure 27 by 36 feet at the base. In building the wooden forms, and for scaffolding, the builders used over 3,000,000 feet of lumber, and into the forms about 100,000 tons of concrete were poured. Buried in the concrete are 2500 tons of steel reenforcement.

The viaduct is known to engineers as the multiple-centered type, which means that the radii, from which the curves of the arches are struck, increase in length from the abutment to the crown of the arch. Primarily, this type is used for its economy of material; but it also gives a curve of pleasing variety and beauty.

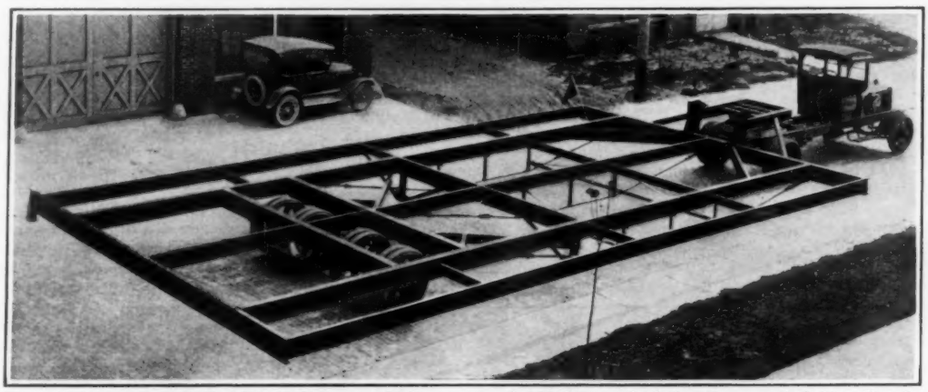
The roadway is carried upon two separate arch rings, the load being transferred to them by molded columns whose horizontal section shows the general form of a cross. The roadway proper is carried upon transverse girders and the surface is formed of heavy or reenforced concrete slabs, the top finish consisting of asphalt with brick between the tracks. The total cost of the bridge was $1,227,859.

Moving a Town by Motor Truck

THE town of Jennings, 11 miles northeast of Cadillac, was founded about a quarter of a century ago by a saw mill company, to house its working force of about 500 men. Jennings was a "company town," and about every able-bodied man was employed in one of the three local mills.

But with the progress of time the standing timber in the vicinity was cut down and for the lack of raw materials it became necessary to close down the mill. After the consideration of various plans it was decided to move the mills, the families, and even the houses to Cadillac, 11 miles to the southwest. The moving of the houses was to be done on a specially constructed trailer, hauled by motor-truck. Accordingly, Mr. W. A. Kysor, president of the Acme Motor Truck Company, designed for the purpose the novel form of trailer which is herewith illustrated. It was so large that it had to be built out of doors.

The next consideration was the road over which the



The special trailer, 24 feet by 42 feet, on which a town of 100 houses is being transported 11 miles by road to a new site

30 to 45-ton load would have to pass. Considerable work had to be done on this highway, such as the widening of the roadbed at a number of points, and in places the laying of heavy planks of timber in order to secure a level and reliable surface. In the village itself entire streets were paved with heavy green planks in order to sustain the concentrated load, since here the soil consists largely of loose, soft sand. The houses vary in size from 24 by 30 feet to 24 by 40 feet, and their weight is from 25 to 35 tons. So stiff and strong is the trailer that not a window has been cracked during the 11-mile journey, except by the limbs of shade trees along the street, which broke one or two when the first house was brought in.

The 11-mile trip is made in about four hours, including all necessary stops to wait for traffic to pass before entering upon a stretch of narrow road. The actual running speed is from five to eight miles per hour. The rate of moving is about two houses every three or four days, although it is expected that as the moving crew gains experience the town will be moved at the rate of a house per day. Altogether there are from 75 to 100 of these residences to be transferred.

The flooring and chemical plant will also be brought to Cadillac. Many of these houses are being sold to working men at a very reasonable price, thereby making it possible for a man who receives average wages to own a comfortable home with all modern conveniences for considerably less than $2000.

The trailer is constructed with a framework of heavy structural steel beams. A channel and I-beam platform, raised 18 inches above the trailer frame and rigidly connected to it, transfers the load at the forward end of the trailer to a rocking fifth wheel mounted on the truck. This construction eliminates twisting stresses from the trailer proper. At the rear the trailer frame is supported by four steel truck wheels placed abreast, which are equipped with dual 40 by 6-inch solid truck tires. They are so placed that about 75 per cent of the weight of the trailer and the house is carried by them, an arrangement which prevents any overloading of the truck which is used for motor power. The trailer which is 24 feet wide by 42 feet long is built up of five longitudinal members, held in place by two main and four supplementary transverse beams, and the whole frame is diagonally cross braced. The three center longitudinal members are reenforced by truss rods.

The four truck wheels at the rear are in pairs, each wheel running on tapered roller bearings supported by a tubular steel axle shaft. The load is transferred to the wheel shaft through coil springs attached to the trailer frame. This arrangement cushions the load and provides for road inequalities. The motor is of 55 brake horsepower.

Moving day in the town of Jennings, Mich. One of the 100 houses en route to its new location

Film Statistics

ACCORDING to a statement of a responsible manufacturer, there was an output of 650,000,000 feet of motion picture film for 1921, and about the same for 1922. This is enough film to go five times around the earth at the equator. At the usual rate of (approximately) a foot per second, it would take a single operator 180,000 hours to project it; or, working 24 hours per day, 7500 days—20 years and seven months. It contains enough guncotton, according to best estimates, to blow up 14 battleships, with the Brooklyn Bridge thrown in for good measure. If it were ignited to flame under a kettle half a mile across and of proportionate height, filled with water, the water would boil throughout.

As a final blow, it may be pointed out that, at the traditional rate of 16 pictures per foot, there have been no less than 10,400,000,000 individual pictures displayed to us on the screen during the year—assuming, what is far below the truth, that each piece of film has been run but once.

A Mechanical Solution of a Literary Problem

An Explanation for the Divergent Sequence of Events in the Gospels of Matthew and Mark

By J. F. Springer

DOWN through the ages has come a great problem. It has, apparently, had no adequate solution until recently. The solution—or solutions—now proposed depend in part upon the state of the art of book-making in the first Christian century and upon inventions in use during that period.

The problem concerns the disagreement in the progression of events narrated in the gospels of Matthew and Mark. Nearly all the incidents in the latter document are paralleled in the former; but there are violent discrepancies in the orders of the events.

Those acquainted with Patent Office matters are familiar with the terms "state of the art" and "invention." A very precise and minutely detailed industrial history of the United States could, for the period since the authorization of patents, be written simply from the official record of the Patent Office. In the patent specifications, all the things described but not claimed could be assumed to represent at the moment the state of the art; while the things claimed would represent the advances termed inventions.

In a similar way, the industrial history of the world could be investigated back by means of such records; but this history would not reach more than, say, a century or a century and a half. When we go back to more remote times, we at once find ourselves limited to vague and fragmentary indications. There is probably no industrial art of which a reliable and detailed history may be given for any period prior to 1000 A. D.

If we attempt to trace the history of book-making to the early centuries of the Christian era, we discover many points upon which no certain and decisive information may be given. And yet, there are some facts of interest and importance which have been ascertained. We know that for centuries all literary, legal, governmental and business documents were written on papyrus and parchment in the form of rolls and codices. But if some one asks, When was the first roll made?, no one can answer. Nor is there any better knowledge of the origin of codices. Pliny, who lived in the first Christian century, gives a technical description of the manufacture of the material papyrus. But his account is incomplete. We know, however, something of the state of the art for a couple of millennia prior to his time, because we have the actual remains of papyrus rolls from these early days.

These rolls present the reading matter in columns parallel to the axis of rolling. We do not know, however, whether such columns resulted naturally and slowly from stress of conditions or whether some early inventor by a single stroke of genius brought them at once into existence. We do not even know how the rolls were made up. Did the scribe write first upon loose sheets which were later on assembled and glued together, side by side, to make up the long roll? Or, were the sheets, while still blank, secured together and the writing then inscribed? Pliny implies that rolls were prepared blank and then inscribed; Ulpianus (died A. D. 228), the great jurist, speaks of books written throughout but not yet glued. And there is the very ancient Papyrus Westcar, whose inscriptions avoid the seams. Therefore, while one cannot assert it for a certainty, still it is reasonable to believe that in the Apostolic Age rolls were often inscribed first and glued up afterwards.

No one knows, either, when the first codex appeared. However, from the ruins of Pompeii, destroyed 79 A. D., have been brought to light a lot of business documents in codex form. Some had three leaves of wood. They were secured together by a string passed through holes in the left margin. Pages 1, 4 and 6 were left uninscribed. Pages 2, 3 and 5 were provided with a sunken space for the inscription. This was made not directly upon the wood, but upon a dark colored wax which had been spread over the inscription space. The writing, executed with a stylus, could be read because of the light color of the wood which shone through the thinned places in the wax.

A tablet codex in remarkably fine state of preservation, due to the fact that it was sheltered, in the ruins of Pompeii, against all the vicissitudes of the barbarian invasions and the Middle Ages

Codices of the foregoing form may be called tablet-codices and are to be carefully distinguished from the form of codex consisting of one or more quires made up by laying once-folded sheets within one another and securing the group together by some means, as sewing. This style of codex is still in existence and is essentially what we have in modern printed books.

Tablet codices were made of parchment and papyrus as well as of wood; and the first use of this style of codex certainly was for business and legal documents. The direct evidence is not sufficient to warrant a conclusion that in the Apostolic age it was entirely the custom to commit literary works to tablet codices in place of the older rolls. But the probabilities are on this side. The state of the art of book-making had, centuries before, reached the point of making codices. And literary books were often made on papyrus and parchment. The step required to produce a literary document in the form of a tablet codex of either material would not rank as invention. The already existent business and legal codices of wood supply the models. It only remains to make the codex with more leaves and a material well known and right at hand. It is very reasonable to suppose that, in the first century, men did at times produce such documents as the several Gospels in the form of a tablet codex made of papyrus or of parchment. Further, it is also quite reasonable to suppose that in making up rolls of either material small sheets were often inscribed in advance of being glued.

This papyrus manuscript of a Commentary on the History of Thucydides is typical of the sort of fragments out of which the average modern version of ancient literature is pieced together

If we grant these conclusions, we have the foundation for some of the solutions of the problem mentioned. However, there are still other related explanations which do not depend upon these results. These turn on such considerations as the tendency of leaves to come loose from folded-sheet codices, of either material; and of rolls to break transversely.

The discord between Matthew and Mark has to do entirely with events falling in the first third of the latter gospel as it exists today, with their parallels in Matthew. It is conceived that in some very early copy of Mark, the first third broke up into fragments consisting of leaves and small groups of leaves or of columns and small groups of columns. When the repair was made, the original order was lost, largely because of the lack of pagination and the absence of other copies to serve as models. And so another order was produced.

Some, perhaps, will think our present Mark has the original order and that Matthew obtained its order from the deranged copy. Others will think that the original order of Mark was that of Matthew and that the present order is the result of the derangement. There is a question of probability involved here, which we have not the space to discuss. There are questions also of small page and variation of page size. These and other points, the reader who desires to look into the matter further will find very fully discussed in the writer's presentation of his discovery in the April and July (1922) issues of *Bibliotheca Sacra*.

The mechanical solution, along the line followed in the present instance, of the textual problems presented by ancient books promises to have a wide application, as it is very reasonable to suppose that ancient documents often went through many vicissitudes.

Vivisection and Animal Industry

WHAT has vivisection accomplished for the live stock industry in the United States? This was the unusual inquiry recently received by the United States Bureau of Animal Industry. Without animal experimentation, whereby a virus was developed for combatting yellow fever, the Panama Canal could not have been built. Pertinent, then, is the question what vivisection has done in behalf of domestic animal life whose members are sacrificed that the ends of demonstration may be furthered.

Animal experimentation has been an instrumentality in ridding the cattle tick from an area exceeding half a million square miles—an area equal to the combined dimensions of Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas and Louisiana. The Texas or tick fever is transmitted by parasites whose control is effected by drenching the infested animals in a dipping vat containing a solution poisonous to the ticks. Seventy per cent of the area originally subject to quarantine has been released. During the fiscal year of 1920 there were 35,045 cattle-dipping vats in operation, the inspections or dipping for the twelve-month period numbering 44,813,070. A laboratory force is employed for developing and examining dips and disinfectants designed to eradicate animal diseases. Thus the production of beef and dairy products—an immeasurable contribution to a nation's food supply—is enhanced.

Sheep scab is produced by a parasite known as a scab mite, bearing similarity to the human itch-mite. Vivisection has made possible a study of the life habits of the mite and has been responsible for developing an effective remedy for this disease. Activities of the Bureau of Animal Industry during the past year involved the supervision of 9,515,720 dippings and 20,371,965 inspections afield in effort to eradicate sheep scabies. The range areas, where the disease was formerly rampant, have been largely freed from the parasite. Likewise conditions in the sheep-raising States have evidenced improvement.

Worms and other internal parasites, which levy an excessive toll of wool and mutton from the flocks of sheep in the United States, have been arrested by animal experimentation. The stomach worm is the worst foe of sheep and in the absence of investigations in the laboratory and afield in discovering methods of prevention and treatment the losses therefrom would attain staggering proportions.

Animal experimentation has contributed to the knowledge of methods for staying the progress of the most infectious and destructive cattle plague—the foot-and-mouth-disease. Domestic live stock in the United States is constantly exposed to the invasion of this foreign malady, the virus of which may be readily carried in the bodies of the animals, in hides, and in other live stock products. The disease is of increasing prevalence and virulence in Europe, and until recently Congress authorized an annual appropriation of $1,000,000 for the suppression of the foot-and-mouth plague in the event of an outbreak. This emergency fund has been pruned to $50,000. The year 1916 witnessed the last outbreak in this country. Cattle infected with the plague are slaughtered and deposited in a deep ditch. The hides are destroyed or mutilated. Experience has justified the procedure of killing the diseased animals rather than jeopardize the entire cattle industry by permitting a continuation of the existence of the affected live stock.

Giddy sheep—a condition produced by a parasite resembling a delicate bladder filled with fluid entering the brain of the affected animal—are subjected to vivisection in establishing a remedy. This fatal disease is caused by sheep becoming infected from grazing on pasturage that has been contaminated by the excreta of dogs infested with a certain species of tapeworm. Canines acquire the tapeworm from eating the brains of giddy sheep—so the transmission of the disease is perpetuated by an interlocking link between the wandering cur and the sheep. Such facts, and the approved methods of prevention, were established by animal experimentation.

Hog cholera is controlled by serum and virus, discoveries due to research in laboratory and afield with live animals. The Bureau of Animal Industry, during 1920, manufactured 525,043,761 cubic centimeters of anti-hog-cholera serum and 22,838,784 cubic centimeters of simultaneous virus. The magnitude of the private industry of manufacturing serum and virus is suggested by the record that within twelve months 135 licenses were issued to 93 commercial firms for the preparation of 177 products of 69 general classes. Recent experiments conclude that neither stable flies nor house flies are vehicles for the dissemination of hog cholera. Hog-cholera control is now jointly conducted by the United States Department of Agriculture and the authorities of 34 States.

Eradication of tuberculosis of animals is a major project of the Federal Bureau of Animal Industry, the tuberculin test being a creditable achievement of animal experimentation. For the fiscal year of 1920, altogether 695,364 cattle were tested. Of these, 28,616 reacted, indicating a presence of the disease, and were removed from the herds. Other than the fully accredited herds, 16,599 other groups of cattle containing 257,577 animals have passed the first official test, no diseased members being found. Forty-five States and one territory are actively participating in the organized effort to eradicate tuberculosis. The Bureau of Animal Industry, during 1920, supplied to Federal, State, county and city officials 5,517,040 cubic centimeters of tuberculin for the testing of animals for tuberculosis.

Finding Uses for Raw Rubber

WHEN a score or more years ago enterprising factors in the rubber industry of the world laid their plans to cultivate the rubber tree artificially and produce rubber on plantations under strict scientific control, so as to get away from the difficulties and dissatisfaction experienced with the jungle product, they did not foresee conditions as they have existed for the past two or three years in the rubber market. Over-production was far from their minds. But their plantations were successful and have flooded the market with excess production. To counteract this condition, extensive experimentation and propaganda were undertaken to find new uses to absorb the excess production. As is well known, the rubber imported to this country and Europe is the coagulated product of rubber latex, made right at the plantations in Ceylon or in the jungles in South America and Africa. Very little of the latex was shipped in the uncoagulated condition. But recently it was found that the latex itself possessed potentialities of application which were never thought of before. The direct use of the latex is now enjoying development into what looks to be one of the most important outlets for the rubber production of both the plantations and the jungles.

In England, where the rubber question has been given most serious attention, a patent has been issued for the use of rubber latex for making a special rubberized paper. Reports of the latest developments are wanting, but it appears that the latex is added directly to the paper beater. In this machine the paper stock is ordinarily beaten up into a pulp in the presence of water. It is a simple matter to add the correct proportion of the latex and continue the beating until a thorough incorporation is secured. A little acetic acid or some acid mineral salt is then added, converting the latex into a gel. The paper-making process is then carried out in the regular manner. The drying of the paper under heat also serves, after the addition of sulfur, to vulcanize the rubber. The product is a paper of high strength and considerable resistance to shear. It is claimed that a very good grade of paper can be made in this manner from a rather poor quality of pulp.

Another use for rubber latex has been suggested in the manufacture of tile and slate for building purposes. The rubber latex is mixed with sulfur, sand and other mineral matters, and can be given any desirable color by the admixture of the proper mineral pigment. Each particle of the mineral matter is surrounded and enveloped by a coating of rubber. Coagulation takes place within the mixer. The paste is then pressed into slabs, which are dried and vulcanized. It is expedient to vulcanize the sheets partly, then to cut them to form and continue the vulcanization of the tiles in molds. Solid masses of considerable mechanical strength are obtained in this manner.

Rubber latex can also be used to good advantage in the manufacture of blocks for paving streets. In this case the composition contains a considerable percentage of powdered waste of various sorts. Only one condition need be fulfilled when using this material, and that is that the powder be made as fine as possible. The mixture is compressed very strongly so as to squeeze out the water and agglomerate the fine dust particles. Slabs about one meter square and four centimeters thick are made from this mixture. Then other slabs about one centimeter thick are made from a composition richer in the latex; and this second slab is placed on top of the first and the two are subjected to pressure again, so as to secure one solid piece. Then the slabs are cut into blocks, which are placed in molds and vulcanized.

By a slight modification of the ingredients in the mixture and the proportions used, it is possible to make compositions which can be formed into various forms of insulators for electrical purposes.

Race tracks, tennis courts, football fields, fields for playing croquet and other sports can be lined with rubber latex compositions. It is conceivable that certain important advantages can be secured in this manner. The ground can be made softer and still just as springy or even more elastic than heretofore. For this purpose the composition is tinted with chrome green or any other desired mineral pigment. The mixture is made with a shovel and then applied to the ground and smoothed out and pressed down by means of a roller. The composition contains only a small percentage of rubber, but this can be vulcanized in the cold, if it is so desired, by the admixture of oxide of zinc, aniline and sulfur. However, the sole function of the latex in this case is to bind together the particles of powder; consequently, the vulcanization of the rubber can be omitted, provided the compression produced by rolling is sufficiently great.

To understand clearly the possibilities of the application of rubber latex, it must be remembered that this liquid is capable of being converted from a mass, that looks like a thickened milk, to the state of a soft solid, and then if the proper ingredients have been mixed with the latex originally, this soft solid, crude rubber can be vulcanized and changed into a hard mass—ordinary hard rubber. Now, if these changes take place when the rubber latex is mixed with other materials, either mineral or vegetable, and is formed into plastic shapes and forms of every conceivable size and contour, the final result will be a solid mass, possessing the properties of hard rubber in addition to those of the powdery ingredients with which the latex is compounded. The latex acts as a binding agent, holding together in a firm, fast union the individual particles in the mixture, and uniting all to form a solid substance. The ease with which the plastic mass can be molded, the simplicity of the coagulating and vulcanizing or hardening processes, make the further development of this new field of the rubber industry one of great promise.

For example, linoleum is made by mixing various finely ground materials with linseed oil and other drying oils. These oils harden and form the agglomerating mass which holds the particles in union. Rubber latex could be used in the place of linseed oil; it would give the same if not better results and it would probably be much cheaper than the oil.

Corrosive liquors, particularly liquors containing acids, must be kept and moved from place to place in vessels and conveyances which are not attacked by the acids. Hard rubber is acid-proof. Sand or asbestos or some other suitable mineral substance, which is not attacked by acids, could be made into a plastic composition with rubber latex and the suitable materials to accomplish subsequent vulcanization, this composition could be molded into any shape or form, no matter how complicated that might be, and the latter might then be subjected to the proper temperature to vulcanize the rubber. The result would be a hard, firm, compact, solid mass, possessing considerable mechanical strength and high acid resisting powers. Piping, tanks, vats, pans, kettles, vessels of all sorts, could be made in this manner for use in the manufacture of dyes, drugs, perfumes, and a large variety of products, in whose manufacture acids are used.

Rubber is impervious to water. Masonry, brickwork, concrete, cement, stone, wood and other materials used in the construction of buildings are not. They must be waterproofed and protected against the action of the atmosphere by being coated with protective coatings, paints, varnishes, etc. Rubber latex might be mixed with suitable coloring matters and perhaps with other finely ground ingredients, and the mixture might be applied with a brush or by means of the spraying machine. The rubber would coagulate and vulcanize if the proper vulcanizing ingredients are added to effect this phenomenon in the cold—these ingredients are usually aniline oil, zinc oxide and sulfur—and the result would be a covering over the cement wall, for example, which would be impervious to moisture and would act as a protection against the weather.

It has also been suggested that the rubber latex can be used directly in the making of roads by mixing it with sand and powdered waste materials, such as old tires, spreading it over the surface of the ground and rolling it smooth with the aid of steam rollers.

Fishing for Pearls

An Old-Time Industry to Which the Flavor of Romance Still Clings

By Charles Henry Dorr

Photographs by Courtesy of the American Museum of Natural History

FISHING for pearls, or pearling, is one of the most fascinating industries in all parts of the world, and the pursuit of these sometimes illusive gems of the seas is also profitable. The value of these pearl bearing shells gathered in almost every quarter of the globe annually runs into the millions. There is a certain glamor attached to the quest for the valuable pearl-bearing shell, for the element of chance enters into the life of the pearl fisher or pearler. One day he may search industriously for pearls of great price and his efforts will not be rewarded, and then again he will succeed in bringing up from the ocean's depths a cluster of perfect specimens of mother-of-pearl and in the cluster may be a pearl of unusual beauty and great value. Such a prize gives zest to pearling. And many a rare pearl is found off-shore in some remote region of the South Seas, or other far away clime in the tropics, where rich and vari-colored shells abound.

While the bulk of the supply of pearls for the world's markets comes from Australia, these gems of the ocean are also found along the coast of the South Sea Islands, North and South America, the Red Sea, along the Persian Gulf and in far away Ceylon.

Mother-of-pearl consists of a large oyster shell, a bivalve, in reality two shells. The mother-of-pearl is actually built in two sections in layers, but almost imperceptibly so. It can be easily split and out of one solid portion a blank is taken from the thickest part of the shell, and from it may be made a number of buttons.

There are two kinds of mother-of-pearl shells in the world. They are divided into the Meleagrina Margaritifera (the large size), and the Meleagrina Margaritifera Radiata (the small size, about the size of a silver dollar).

The radiata or small shell is found in the waters of the Persian Gulf, at Ceylon, in the East Indies, and in Northern Venezuela, and on the Atlantic Coast. The small-shell pearl producers abound in these regions. The large-shell producers abound in a vast territory all along the northern coast of Australia, Queensland, Western Australia, and on the coast of North and South America, the Dutch East Indies, in the waters of the Red Sea, the Black Sea and the South Sea Islands, and on the coast of Mexico and Lower California. It is, however, of inferior quality in Mexican waters and also on the Lower California coast, according to the reports of pearl fishers, who have gathered the pearl-bearing shell in this part of the Pacific.

Almost as many colors as tint the rainbow may be found reflected in the shells of mother-of-pearl throughout the world. The most valuable of all is the perfect white shell, which is found by the pearl fishers in Australia, Queensland, and along the coast of North and West Australia, as well as in certain regions of the Islands of the Dutch East Indies. It is used for fine cutlery, jewelry, including brooches, and for various novelties for which it is adapted.

Then there is a yellow shell fished for in the Philippines, and in and around the region of Manila. It is known as the Macassar shell. This yellow shell is also found in an almost endless chain of islands in the Dutch East Indies. It is used for novelties in the manufacture of objects composed of pearls.

Another pearl-bearing shell is of a greenish tinge and abounds in the Red Sea, and some islands of the Indian ocean, including Sokotra. The green shell is used for the cheaper quality of buttons by the manufacturers, and also for colored buttons. A pearl of the same color is found in Egyptian shells and at Zanzibar. There is also a shell of greenish hue found in Mexico, and along the coast of Lapaz, Mazatlan and Acapulco.

The South Sea Islands yield a shell black in color, and this shell is also found by the fishers for pearls in the French possessions of Tahiti and the Gambier Islands. The black pearl-bearing shell is also abundant in the smaller Fiji Islands and the lesser isles of the South Seas, and in the islands of the Dutch East Indies. It is used for the so-called smoked pearl for various types of buttons and for ornamentation of ladies' garments.

Of natural color are the ear shells of Japan, and many of these shells, when brought up from the depths of the sea, are iridescent and glisten in the sunlight when taken from the water. They are used for buttons on Palm Beach garments.

The well known abalone shell is fished for by the pearlers along the coast of the Pacific in the United States and in Mexico. It is a beautiful shell and attractive in color. The abalone shell has green ears, and some are in black ears with blue backs. Many fine specimens are gathered along the Lower California coast in the waters of the Pacific. The abalones are used for decorative purposes and to quite an extent for seashore jewelry, the color lending itself for ornamental pieces. The Gulf of California has long been famous as a rich fishing region for rare and beautiful pearl-bearing shells, and some remarkably fine specimens have been obtained in these waters along the coast.

The red abalone shell is abundant off Point Loma, and on the shores of Catalina and Santa Rosa Islands in the Pacific, and in the region of Mendocino County. The fishery is confined to the rocky portion of the coast and the near-by islands. Aside from the red abalone there are several other varieties of interest, including the green, black, pink and corrugated. They are used for novelties and decorative objects, and inlaid work.

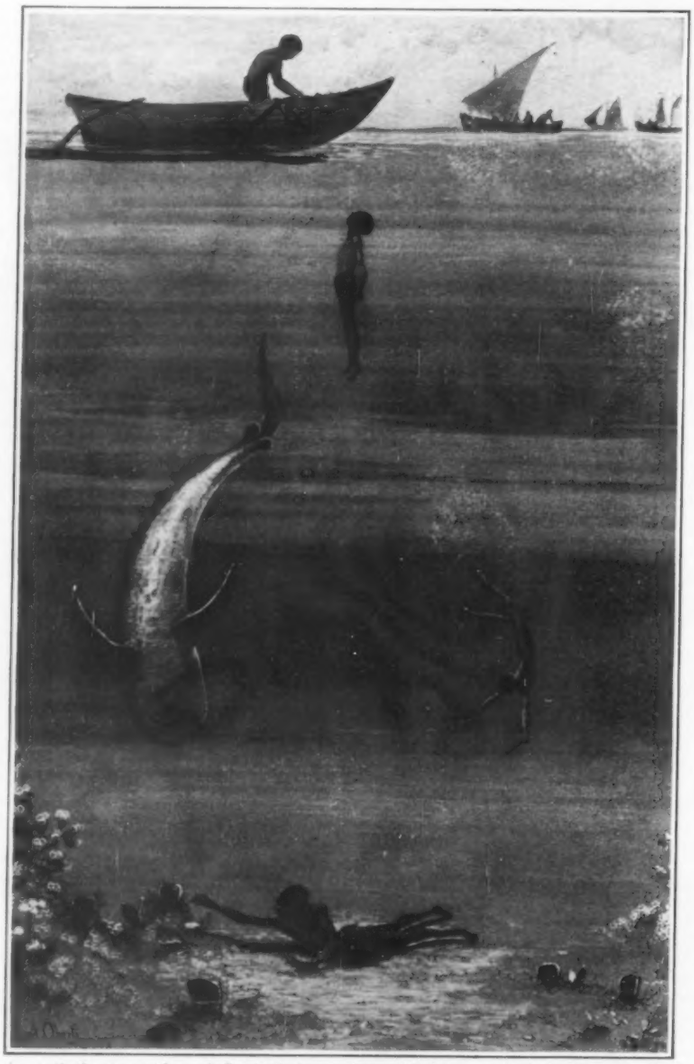
Still another shell is known as the Trocas, white in color, and of cylinder form, and used extensively for the manufacture of buttons. The white Trocas is found principally in France and Japan, and is abundant in all parts of the tropics, and the Dutch East Indies. This shell is also gathered by the pearlers in the waters of the Fiji Islands, in the French possessions, in the waters of the Red Sea, and in New Caledonia.

There are four ways of pearling: beach combing, natural plunging, dredging and diving in a modern diving apparatus. At low tide the shell-bearing pear lies on the surface and offers a favorable opportunity for the pearler who gathers up the shells before him by the beach combing method. This may seem primitive, but it is a natural method which is employed by many pearlers who gather quantities of pearl-bearing shells at low tide.

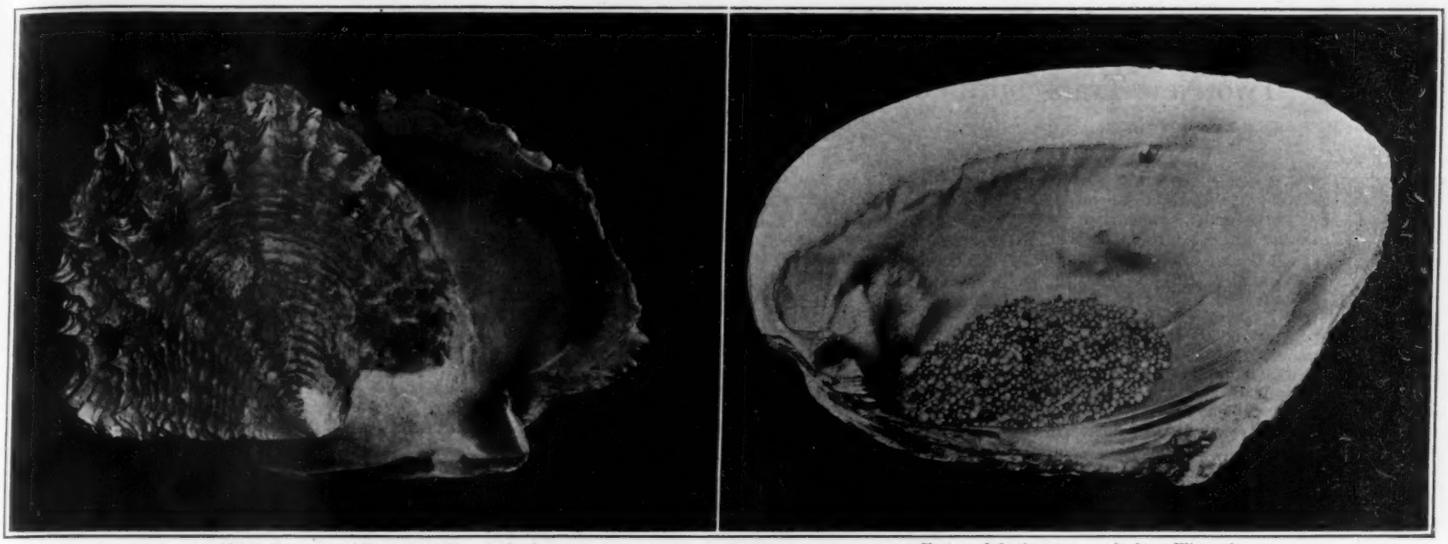
Then there is the natural method of plunging into the sea for pearls, which is still practiced by pearlers in the waters of the Red Sea and the Persian Gulf. One of the great centers of the pearling industry is the Bahrein Islands, situated on the eastern shore of Arabia in the Persian Gulf, and under British protection; here the value of the pearls in some years exceeds 500,000 pounds. The divers are chiefly Arabs, but include Persians and negroes from Nubia. Large sea-going scows are employed. The diver stands upon a stone of about twenty pounds weight, which is tied to a diving rope of three to four inches in circumference. He is attired in a loin cloth to which a basket for the oysters is attached. His equipment includes leather guards for his big toes and forefingers, and horn pincers for his nose. He swiftly glides to the bottom of the sea, and if the locality is good for fishing he will fill his basket in thirty or forty seconds. The water abounds with sharks, but the loss of life from this cause is said to be very small. The divers are most industrious and work diligently from sunrise to sunset in quest of the pearl.

Another method employed by the pearlers is dredging in the mud, or upon the sandy bottom of the sea. The river dredges are equipped with long-toothed rakes and a windlass. When the dredge is closed, the tines thoroughly rake the bottom of the water-way, and when completely closed every mussel and rock in the space covered, except those so small as to pass through the openings, is taken into the basket. Continued winding of the windlass brings the dredge out of the water, when it can be lowered into one of the boats and opened. Then the debris is sorted out and thrown away. Heavy dredges, it is said, are more effective than light ones. A new form of dredge has been invented, which is operated by power, and brings the mussels continuously from the bottom by means of an endless chain and buckets, and is said to work successfully.

As very few red abalone shells are exposed at low tide and as they are not found in water deeper than will permit the penetration of sufficient sunlight to



An artist's conception of the technique of pearl-fishing, and of the dangers that accompany this trade



Meleagrina margaritifera, from New Zealand — Cluster of fresh-water pearls from Wisconsin

Pearls are found in all parts of the world, and in molluscs of a wide variety

support the vegetable growth on which the abalone depends for subsistence, they are mostly secured by divers, who use a regular diving outfit such as wreckers employ and other workers who go below the surface of the sea. A diving outfit including the helmet, suit and air pumps and other paraphernalia usually costs about $800. The divers are principally Japanese, for it appears that they are experts in diving to the depths of the sea, and the pumps and life lines are usually operated by men of their own selection.

The depth of water in which they operate varies, but does not often exceed 125 feet. Some divers, however, have managed to work successfully at 150 feet below the surface of the sea. These divers rarely go out of sight of land and work only when the water is smooth. Often they are thwarted in the day's work by the sudden rising of tempestuous seas. A diver usually remains under water from two to three hours, and while operating on the bottom of the sea, he uses a short iron bar to pry the abalone off the rocks.

When secured the abalones are hauled up to the boat in carriers made of manila rope about one-fourth of an inch in diameter, and one of these is attached to each end of a line suspended from the boat, and as one carrier is raised the other is lowered. For shoal water fishing the pearl fishers use a boat and a hooked pole.

The value of the abalone industry is three-fold, consisting of the pearls, which are only occasionally found; the shell, which is used for making pearl buttons and novelties, for inlaid and ornamental works, and the flesh or meats, which when salted or preserved in cans forms a valuable article of food.

In Japan the pearl divers plunge into the water without any apparatus, and it is said that they remain under the water from 60 to 80 seconds, long enough to bring up a cluster of gems from the depths of the sea. The Japanese girls are most efficient divers, and their dress for the work consists of thin, tight white garments, which afford freedom of motion while diving. A large part of the submarine work in the oyster culture of Japan is accomplished by women divers in Japan, or sea girls, as they are called in the Orient.

The controversy that has arisen in the pearl trade recently over the prominence of the Japanese in this industry is due to the claim made by or attributed to Mikimoto, that after many years of experiment he had succeeded in producing "culture pearls" closely resembling the actual product. There is probably a difference of opinion among the experts in regard to the merits of this claim. In this country, among the pearling industry workers and experts as to the value of genuine pearls, there is a tendency to accept it with no little degree of caution.

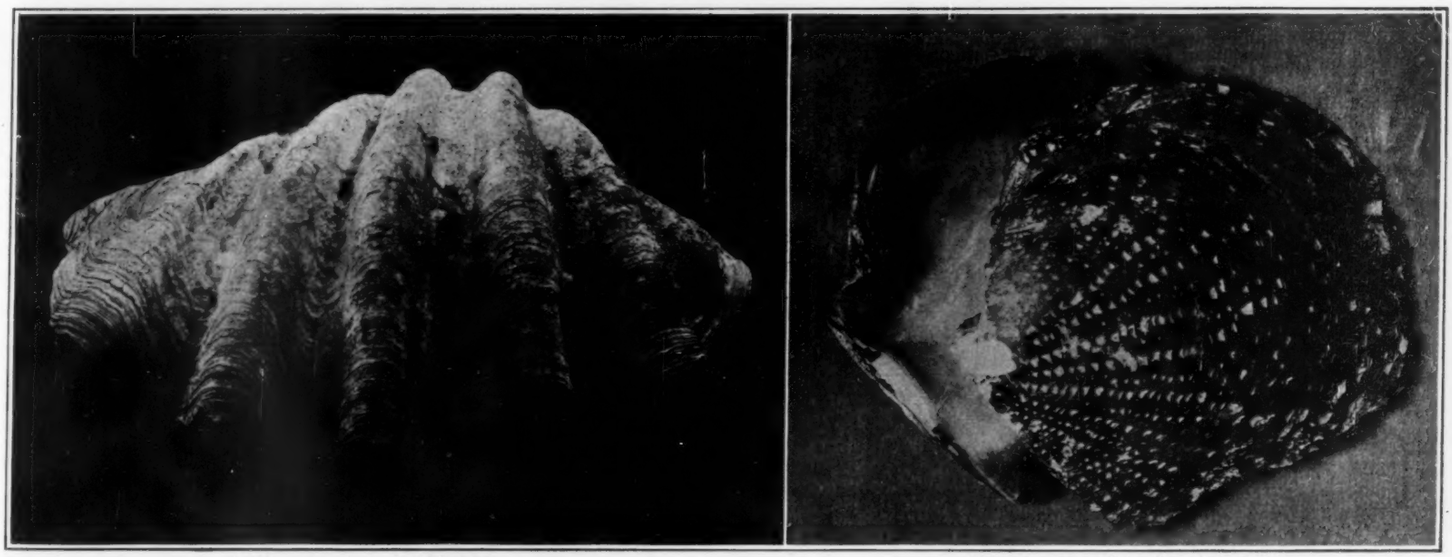
Mikimoto has been experimenting in the culture of pearls since 1879. His pearl culture station was established in 1890 on the island of Tatoku in Agu Bay, Province of Shima, Japan. At last accounts his pearl fields extended over an area of some 10,000 acres.

A writer for one of the publications of the Bureau of Fisheries, at Washington, D. C., says with reference to the "Culture Pearls": The Japanese have produced "Culture Pearls," which are not true pearls, but which are portions of pearls that are fitted together to produce the effect of the perfect pearl. The units composing the culture pearls are coated with a true pearly substance produced by the pearl oysters under methods of artificial cultivation. In the opinion of this writer such experiments have not proved successful in a commercial way. The connoisseur will doubtless prefer the genuine pearl brought up in its pristine state from the depths of the sea.

The value of the pearl is regulated by the demand in the market, and this holds good all over the world, according to the authorities in the pearling industry, and the demand is dominated more or less by the fashions. With fashion's decree the value of the pearl is determined, and the price depends altogether, it is said, upon the quality of the shell. The perfect shell, of course, commands the highest market price. The white shell is always marketable for it can be utilized for various types of buttons, shoe buckles, knives, revolver handles and inlaid ware. For large cloak buttons the white pearl is particularly desirable.

The perfect pearl should be spherical or of a perfect pear-shape. One of the finest specimens in existence is said to be the pearl known as the "Pellegrina," in the Museum of Zosima at Moscow. This specimen is a globular Indian pearl of unusual beauty and weighs 28 carats. Perhaps the largest pearl in the world is in the Beresford-Hope collection at the Victoria Albert Museum, England. It is of irregular shape, weighs three ounces and is surmounted by a gold crown.

In concluding this story of the pearl, the writer wishes to make acknowledgment for data obtained through the courtesy of Mr. Ludwig Stross, who spent seven years in pearling along the coast of West Australia, where he operated a fleet of ships, and who also has fished for pearls in the waters of the Red Sea; and to Mr. Paul Rie of New York.



Tridacna gigas from the Philippines — Meleagrina margaritifera from the East Indies

Further examples of the geographic and biological distribution of the pearl

Railroad Building in the Andes

Two New Transcontinental Lines to Pierce the Rockies of South America

By Leonard Matters

AT THE end of last April an agreement was signed by the Governments of Argentina and Chile under which two great engineering projects are to be carried out, equal in their magnitude to anything that has yet been achieved in the field of railroad construction. The Andes Mountains — the "Rockies" of South America—are to be pierced in two places, separated by nearly a thousand miles.

Conservative opinion doubts whether the two lines can be completed within the three years' time specified. It is still more skeptical about the financial results of the very costly undertaking, but there is common appreciation of the boldness and wide vision behind the project that will give the two countries three great transcontinentals scaling in their course a mountain barrier of tremendous proportions.

To understand the nature of the proposed new transcontinentals it is necessary to glance for a moment at the existing route across the Andes and note the main features of the railroad which will be more or less duplicated on the two lines to be constructed. From Buenos Aires to Valparaiso the distance is 895 miles, and the line embraces three distinct sections and systems. From Buenos Aires to Mendoza (651 miles) the 5½-foot track is operated by the Pacific Railway Company. At Mendoza the gage changes to 3 feet 3⅜ inches (one meter) and the Transandine Railway Company operates the 154-mile section, which actually carries the line across the frontier and 40 miles down into Chile, to Los Andes where the Chilean State Railways are met. From here to Valparaiso there are 91 miles of 5½-foot track.

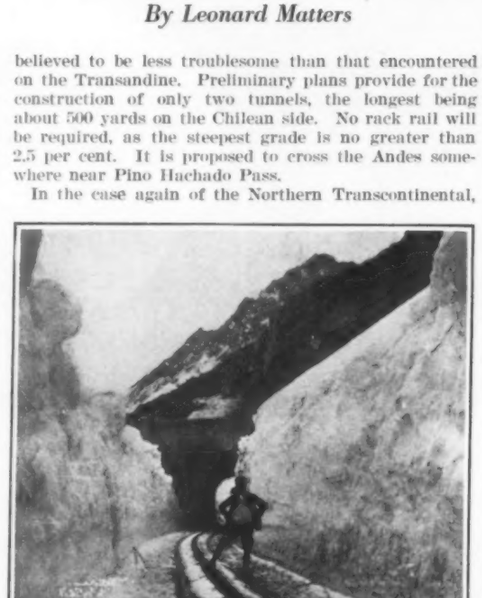
The Transandine line was formally opened in April, 1910. It is this comparative short section of 155 miles which embraces the entire problem of traversing the Andes, and as an engineering achievement the work is admitted to be of the first magnitude. On the Chilean side there are 25 tunnels and 18 bridges, while on the Argentine side there are nine tunnels and about as many bridges. In addition there is the main tunnel, 3,463 yards long, which pierces the main range beneath the Uspallata Pass, directly under the frontier line, and close to where General San Martin made his famous crossing in 1818.

In the main tunnel the highest altitude of the line (10,470 feet) is reached. Mount Aconcagua, Monarch of the Andes, towers 23,393 feet above the level of the sea, and gazes from beneath his snowy crown upon the work of man. On the Argentine side there is a fairly stiff climb from Mendoza to the frontier, the line rising from 2,520 feet to 10,470 in 111 miles. On the Chilean side the grade is much sharper, for in a distance of 43 miles there is a descent of 6,747 feet, Los Andes being 2,723 above sea level. The steepest grade on either side is 8 per cent, and as this is common enough over considerable distances, the Abt system of rack and pinion was found necessary, and is installed over about 27 miles of the track. Special locomotives, designed to engage the central rack, are utilized over the Transandine section of the route.

Approximately 500 miles south of the Buenos Aires-Valparaiso line is the route for the Southern Transcontinental, the first of the two new lines to be constructed. Its main terminals will be Bahia Blanca on the Atlantic seaboard and Valdivia on the Pacific. Here, as well as on the northern route, the problem is just about the same as that of getting through or over the Andes between Mendoza and Los Andes. From Bahia Blanca to Zapala the Great Southern Railway Company has a line in operation, and on the Chilean side of the frontier the State railroads approach fairly close to the mountains. Between the two systems there is a gap of 140 miles—72 on the Argentine side and 68 on the Chilean. When this connecting link of line is built there will be a total mileage of 767 between Bahia Blanca and Valdivia.

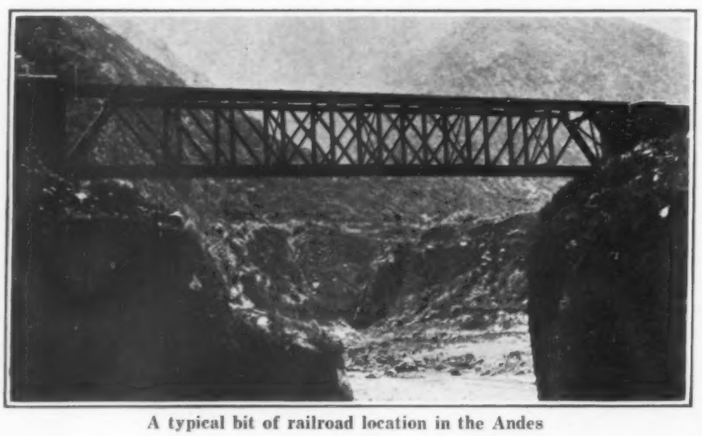
Several routes across the mountains between Zapala and Chile have been surveyed, and no great engineering difficulties other than those incidental to traversing a rugged mountain range are expected. The problem is believed to be less troublesome than that encountered on the Transandine. Preliminary plans provide for the construction of only two tunnels, the longest being about 500 yards on the Chilean side. No rack rail will be required, as the steepest grade is no greater than 2.5 per cent. It is proposed to cross the Andes somewhere near Pino Hachado Pass.

In the case again of the Northern Transcontinental, as far back as 1907 a concession to a Chilean construction company was granted by the Argentine Government, with a condition that the contractors should also build the necessary section in Chile without which, of course, the line to the frontier would be left "up in the air."



Approach to a tunnel through a snowdrift, showing the rack line of the Transandine road

the work of creating a third line between Argentina and Chile involves the construction of a connecting link over the mountain to unite two existing systems. At present there is a main trunk line from Buenos Aires to the city of Salta in the North, and on the Chilean side there is a railroad from the port of Antofagasta toward the frontier. The project for connecting the two has been under consideration for many years, and



A typical bit of railroad location in the Andes

An Argentine technical commission mapped out a route for this line, the plans including the building of 235½ miles in Argentina to the frontier town of Huataquina, and 217½ miles in Chilean territory, crossing, or piercing, the mountains where they reach an altitude of 14,765 feet. A main tunnel, a mile in length, was provided for, and the maximum grade was figured at 5.5 per cent. Officially it was calculated that the cost of the Argentine section would be $14,000,000 U. S. The concessionaires took over the Government plans, but engaged their own engineer to make a definite study of the proposed route. He improved considerably on the official plans, reducing the total length of the connecting link from 453 to 395 miles, and finding a route with a maximum grade of 2.5 per cent. But his estimate of the entire cost of the line on both sides of the frontier was $33,500,000 U. S. It was found impossible to raise the necessary capital, and the concession lapsed in 1914.

The project was again taken up after the war by the State Railroads Department of Argentina, plans were modified to some extent, and the construction of the Argentine section was started in 1921. By the agreement with Chile that country now undertakes to push on with the construction of the line toward Huataquina on the frontier, so that the road can be open within three years.

It is hoped by the building of these two new railroads that immense territories will be developed. The southern route will pass through rich lumber and cattle lands on the Argentine side, and will tap some of the most fertile territory in Chile. Coal and oil are known to exist, and some of the best lumber in South America is to be found in the Andean foothills down south.

In the north, around Salta and between that city and the mountains, oil, copper, coal, gold and silver are obtainable. The mineral wealth is there all right, but so far little has been done to exploit it owing to the heavy cost of transportation of fuel by the long haul from the Atlantic coast. Mining men speak of extraordinarily rich ore in abundance in the Provinces of Salta and Jujuy, but the ore is refractory and calls for special treatment which is not profitable while every ton of fuel and material has to be transported nearly a thousand miles from Buenos Aires. The inlet and outlet to Antofagasta is the natural channel. Since the announcement of the Chile-Argentine agreement important discoveries of petroleum and natural gas have been made near Antofagasta, and this alone suggests that there is a big future for the northern territories of Argentina when brought into communication with the Pacific Coast.

Under the agreement referred to Chile and Argentina are to bring their construction and operating programs into harmony. A technical commission is to decide such matters as the weight of rails, fastenings, rolling stock, locomotives, etc., and the probability is that bids will be invited simultaneously for all the material required. In any case a big opportunity presents itself to manufacturers to take up some profitable contracts connected with the bold railroad policy upon which the two republics have now entered.

Plumbing Committee Report

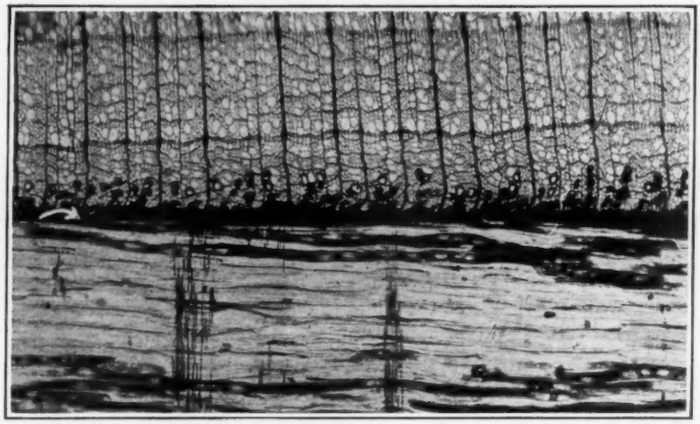
A TENTATIVE report on residence plumbing has been prepared by the subcommittee on plumbing of the Building Code Committee. This report presents recommendations for design of plumbing systems in one and two-family dwellings, and outlines the principles which it is believed should govern the public control of such work through plumbing codes and inspection.

These recommendations are based on extensive series of experiments with plumbing equipment conducted at the Bureau of Standards under the direction of the subcommittee; also on investigations of practice and opinion in all parts of the country. This report is being sent out in limited numbers for comment and criticism and will be revised in the light of such criticism, and the revised report published later for distribution.

Detailed rules of plumbing practice are now being prepared and will be given in a subsequent report. The experimental work is being continued and demonstration equipment, open to public inspection, will soon be installed.

How Glue Makes Things Stick Together

THE accompanying illustration, furnished to us by the U. S. Forest Service, is a greatly enlarged section through a glued joint of plywood. This photograph illustrates a fact not generally understood, that the glue uniting two wood surfaces does not lie in a smooth sheet but enters the cell cavities through the open ends on the cut surface and clinches the joint by means of millions of tiny barbs and anchors. The arrow indicates the point at which the glue entered the pore to the left of the glue line. The glue-filled pores near the glue line on the right all open on the cut surface at some point and were filled in the same manner, as little or no penetration takes place through the cell walls. Viscosity and pressure must be adjusted to suit the character and the number of cells and pores in different kinds of woods to obtain the strongest joint.



Greatly enlarged section through a glued joint of plywood, showing how glue unites two wood surfaces

Variations Found in Leveling Devices

THERE is a marked difference in the sensitiveness and quality of spirit levels offered for sale for the use of masons, carpenters, machinists and the like. This has been brought out by field studies of the Bureau of Standards in the installation of heavy capacity scales. In examining the alinement of scale parts installed in pits, certain discrepancies were noted. Attention was finally directed to the leveling devices used, and a simple practical scheme was worked out by the Bureau for testing them which may be used to advantage even in a small shop. The method was then applied to the test of various levels which were found available in the scale shop.

In three levels of the same make and provided for the same purpose, it was found that one was several times as sensitive as the other. One of the vials likewise showed a marked lack of uniformity in sensitiveness, since a given change of level would cause a greater movement of the bubble from the center of the tube in one direction than the other. The levels tested included an arrangement of two level vials at right angles to each other, which was being used for specially accurate work. It was found in this particular case that there was a marked lack of sensitiveness in this special device, in fact, was much less sensitive than any of the other less pretentious vials which were tested.

It would appear, therefore, that anyone wishing to carry out highly accurate work should be positive that the levels used are carefully made and sufficiently sensitive; otherwise serious errors may result without knowledge of the user.

Wearing Red and Green Spectacles to See Stereoscopic "Movies"

PATRONS of the motion picture theater, if they care to see stereoscopic films, will find it necessary to adopt a substitute for the old-time stereoscope in the form of spectacles having a red and a green glass, as was done by audiences in Los Angeles recently when the first pictures made by the Harry K. Fairall process were projected.

For seven years, this inventor has been working on the process and now has 20 odd patents pending covering various features of the apparatus necessary for the making and showing of such films. In the main, his process is largely the application of the principles of the stereoscope to motion picture film production.

The camera used in the making of the Fairall stereoscopic films contains two mechanisms propelled by one crank shaft. It also has two film magazines. The mechanisms expose simultaneously two frames of film upon which two lenses impress the image then in front of the camera. In addition to perfect synchronizing mechanisms, the most important features of the camera are the lenses. These are placed as far apart as the eyes of the average human. One lens photographs through a green filter and the other lens through a red filter, thereby giving two negatives which contain everything of the image within the scope of the complementary colors.

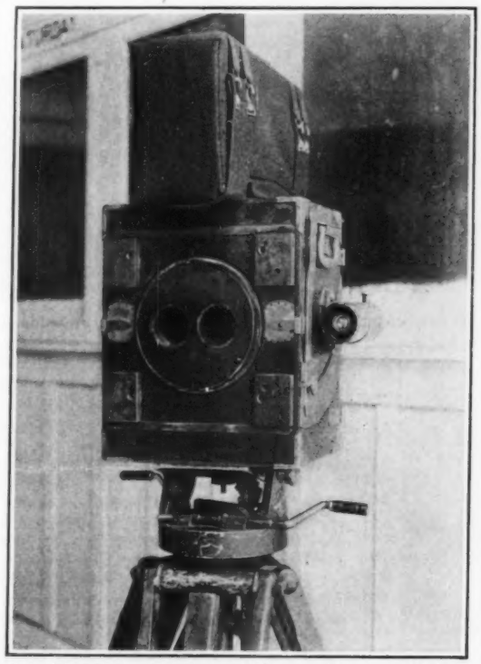
The scheme for finishing the positive prints, which are used in projecting pictures upon the screen at the theater, provides that they shall be printed in the usual way. Extreme care is necessary to insure perfect projection. The same printer must be used for each complementary print without an alteration of the breadth of a hair in the framing device. The print from the red filtered negative is tinted red and that from the green is tinted green. The developing, washing, fixing, dyeing, washing and drying (these are the treatments of the film in the order they are given) must be given to both complementary prints at one time because the moistening of the celluloid and the drying causes expansion and contraction. The solution and water used for both must be of the same temperature or the expansion and contraction would not be the same on both prints and they would not synchronize when projected.

Two projection machines of any of the standard makes are required for showing the picture. These are interlocked in operation by a simple attachment and two films are projected on the screen at the same spot. To the naked eye, the projected picture contains an out of focus image with fringes of red and green around and through the images shown in the picture. This projected picture is corrected for the eye by the use of the red and green spectacles. The projected motion picture when viewed through the colored spectacles is black and white, the colored celluloid of the spectacles having neutralized the complementary colors of the projected picture. The producer plans to furnish to all patrons an individual pair of spectacles, the celluloids of which have been dyed at the film laboratory with the same dyes used for the films. The spectacles can be purchased at a cost of about two cents per pair in quantities by the producer and may be retained by the patron as a souvenir.

The demonstration of the Fairall process proved beyond a doubt that it gives a stereoscopic effect to a motion picture. Scenes taken in Yosemite Valley were shown and gave the viewer the impression that he was looking through a window and within his vision were waterfalls, mountain crags, canyons, trees, etc., extending over an area miles in length. In the foreground the objects were as plain as those in the far distance. Furthermore, the picture was as distinct when viewed from the side near the screen as from the center of the rear of the theater auditorium.

There are a few incidental essentials that need correction before the process will furnish for the screen films as perfect as those of the ordinary black and white or tinted variety now shown universally. It is necessary to make all negatives for this process on panchromatic negative stock which is slightly slower in exposure than the average negative film stock now on the market. It is also necessary to close the diaphragm of the lenses until what may be termed a universal focus is secured. This insures sharpness in all portions of the picture, but at the same time cuts down the amount of exposure to such a material degree that "slow cranking" of the camera is necessary to secure the proper exposures. This feature is apparent in the finished product, for the players are required to move so slowly that at times their action does not seem real.

Another defect in the exhibited film lies in the titles. The ones used for this picture were the same as made for other motion pictures. The projected images or letters on the screen were flat. When the picture passed from the stereoscopic portion of the film to a title or sub-title, there was, it seemed, a jump for the vision to make. It was like looking off for miles and having some one drop a billboard in front of your eyes with lightning like speed. This caused the eyes to refocus. The same change occurred for the vision when a title or sub-title was finished and the stereoscopic scenes again appeared upon the screen.



Special type of camera with two lenses and two negatives for making stereoscopic motion pictures

Testing Kiln Circulation With Chemical Smoke

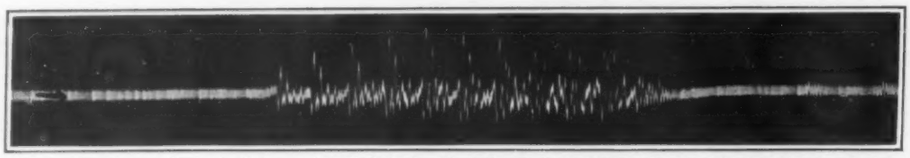
SINCE it is the air that removes the moisture from the surface of lumber in a dry kiln, the movement of the air must be ample in all parts of the kiln, or uneven drying will result. The drift of smoke produced by some burning substance is often used as an indicator for searching out zones of too rapid or sluggish circulation in kilns.

This method is greatly facilitated by the use of the apparatus shown in the accompanying view, which was developed at the U. S. Forest Products Laboratory, Madison, Wis. In this device, the use of which involves no fire hazard, as in burning rope, punk, etc., in the kiln, the fumes of hydrochloric acid are blown across ammonia; and an abundance of harmless, visible fumes is produced. These fumes, being of approximately atmospheric temperature, have little tendency to rise or fall independent of air currents.

Testing kiln circulation with chemical smoke produced by means of hydro-chloric acid and ammonia

Long-Distance Telephone Problems

Getting More and More Messages Through the Same Number of Wires to Reduce Operating Costs



The drawing is an oscillograph of the word "at." It is the job of the telephone engineer to pass such complex series of vibrations as this through the system of wires and to deliver them to their destination undistorted and of their original strength

What the telephone does in translating sounds into electric current fluctuations

INTO and out of a single 26-story building in New York run all of the long-distance telephone wires which carry the voice of the city to every nook and corner of the nation. My guide stopped behind one of the operators.

"This girl is working the Havana wire. Would you like to hear Cuba talk?" inquired my guide.

I was provided with a head-phone, "plugged in" on the board and listened for a few minutes to the routine of establishing connections between subscribers in New York and Havana. There seemed to be nothing wonderful about it. The two operators went about their business just as though they were in adjoining exchanges. For all practical purposes the Havana operator might have been in the next room; indeed it was hard to convince one's senses she was not.

As a matter of fact, the completion of that circuit was an engineering feat of no small magnitude. The final link, a submarine cable from Key West to Havana was only recently completed and I was told that the conversation I heard was carried on partly over a circuit that lay a mile beneath the waters of the Gulf Stream. One might have guessed from the distant operator's linguistic difficulties that she spoke Spanish better than English. I was told that there was some difficulty in finding operators for the Havana end, because the orders received there must be translated into Spanish in order to complete the connections.

But the girls who sit at opposite ends of that marvelous strand of copper are beginning to get pretty well acquainted, and 10-second lessons in Spanish and little confidences are beginning to flit over the wire.

But I have fallen into a common error; rather, I have repeated a commonly accepted myth about long-distance telephony, which it is the very purpose of this article to dispel. Those two distant operators, or any other two distant operators, are not connected merely by a strand of copper, or even by a continuous electrical circuit. To be sure, a strand of copper is the part of that circuit which is ordinarily visible, but scattered along it at intervals and interwoven with it is a veritable "invisible empire." Instead of being a simple electrical circuit, the average long-distance line (that is, two pairs of wires) provides a path for three telephone messages and eight telegraph messages simultaneously. The marvelous apparatus and the complex organization which make this possible are almost beyond the comprehension of the lay mind.

It is not the purpose here to describe the succession of steps in establishing communication between two distant parties, for excepting that the circuits which run out of an exchange end in a distant city and the fact that the operators are separated by miles instead of by city blocks, the procedure is very much the same as establishing connections between local subscribers. It will not be possible here to describe all of the apparatus which goes to make long-distance telephony possible and economical, for that would require a good-sized volume. But if we can give an understanding of some of the newer and more important devices which enter into long-distance telephony and leave an impression of the magnitude of the engineering problems involved, we shall count this space well spent.

The improvement in long-distance communication in the past five years has been very noticeable. Within one man's lifetime (for Dr. Bell lived to see all this) it was a marvelous thing that two men could talk over a pair of wires stretched across the street. It is within the memory of nearly everyone when a long-distance call to a city 50 miles away invariably meant long delays, indistinct transmission, buzzing, noisy lines and all of the other annoyances to which telephones of a bygone day were subject. But today we in New York talk to Havana or San Francisco with almost no delay and perfect voice transmission, as part of the day's business. So quickly does a wonderful engineering feat, when in commercial use, become a commonplace!

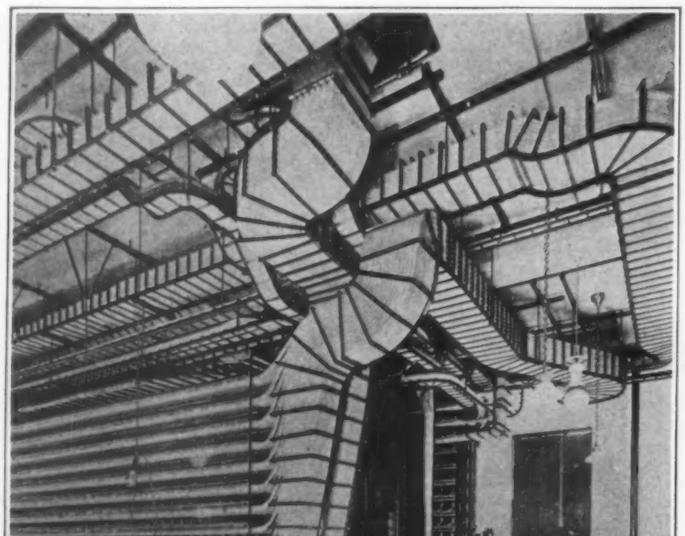
In some respects this improvement has not been an independent development. We have had to wait on the slow accumulation of knowledge and the perfection of devices intended for use in entirely different connections. The development of the vacuum tube amplifier, or, in telephone parlance, "repeater," is a case in point.

Ask the average well-informed man what the vacuum tube repeater is used for and he will tell you of its connection to wireless. But as a matter of fact the vacuum tube amplifier was first developed to a state of usefulness by telephone engineers, and today finds its widest application in telephonic communication, beside which its present-day use in wireless is just incidental. But it seemed for a long time that the vacuum tube amplifier could never be useful in telephony, and competent engineers regarded the first experiments as holding no hope. But there were developed, entirely aside from these experiments, better and more uniform methods of manufacture, better materials were found, and in research laboratories scattered throughout the world, scientific principles discovered which made it possible to overcome all of the old difficulties.

Today vacuum tube repeaters, combined with the benefits derived from "loading" long-distance and cable circuits, put an entirely different aspect on the problems which have confronted the telephone engineer in the past. It is now possible to secure 100 per cent transmission of speech, as far as suitable lines can be built, at a very great saving over old types of line construction. Smaller gage wires can be used in underground or overhead cables in long-distance service and this greatly extends the usefulness of cable. Although the fine wire cable in long-distance construction is one of the newest developments in the telephone art, plans already have been completed for a vast cable network which will cover the Eastern and Middle Western States wherever the number of long-distance messages to be handled is very great and rapidly increasing.

One of the chief problems in designing the vacuum tube telephone repeater was to amplify all frequencies of the human voice equally. The speaking voice is made up of a complex combination of wave forms which may range as low as 100 cycles per second and as high as 3000 cycles per second. It is a simple matter, comparatively, to design an amplifier that will function at a set frequency, as in radio work, but a very difficult problem to amplify the frequency range of the voice without distorting the sound. On the trans-continental wires which connect San Francisco and New York 12 repeaters are used. It will be seen that if each repeater distorted the voice currents only slightly the final result would be but a jumble of sound.

These repeaters are placed at regular intervals along the line and as the currents become weakened they pick them up, and, acting as a valve for energy from a local source, deliver back into the line a current many times stronger, but a faithful reproduction of the original. It is impossible to build an electrical circuit from which there will not be some leakage of current, and when a delicate circuit is carried over fine wires inside a cable with hundreds of other circuits, the leakage is very great. Amplifiers have to be used more frequently, therefore, and if the trans-continental lines were carried all in cable there would have to be four or five times the present number of amplifiers.



Distributing frame to which all the circuits and wire connections from the different pieces of test-room apparatus are brought to facilitate the changes that are necessary from time to time

The loading coil, well known by name, is a simple but important device to neutralize the effect of capacity between the wires of a long circuit. When two wires are strung out near together for a long distance they become in effect an electrical condenser of large capacity. An electrical current sent out over this line charges and discharges this "condenser" rapidly and at each charge the strength of the current is wasted away and the voice currents never reach their destination. The loading coil consists of a core of rings made of compressed iron dust and (in the simplest cases of the ordinary two-wire circuit) there are on it two windings, each in circuit with one of the wires. These coils are placed at regular intervals along the line, and to protect them from moisture they are enclosed in big iron pots which are sealed shut.

Just as the vacuum tube repeater and the loading coil have been largely instrumental in making long-distance communication by telephone possible, so other devices which provide for duplex use of the wires, make it economical. If each long-distance conversation necessitated the exclusive use of one telephone circuit, a talk across the continent would tie up for the time millions of dollars worth of equipment and the cost to both company and subscriber would be prohibitive.

But the same wires which carry voices from city to city at the same time carry the news of the world to our daily newspapers, the stock reports to the centers of commerce, and provide "leased wire" telegraphic communication between business houses.

This is made possible by using an al-

ternating current for the telegraph messages which is lower in frequency than the telephone current. Two such telegraph circuits in each direction can be placed on the pair of wires without interfering with the telephone message. At the receiving end of such a wire there must be an electrical filter system which picks out each of these separate currents and directs them to the proper instruments. The very recent application of the printing telegraph even further increases this wire capacity. With this device the message is received by a typewriter-like instrument instead of by an operator using code signals. The sending equipment of this device is of particular interest. The message is "typed" on an ordinary typewriter keyboard, but in addition to printing the message on a paper, the manipulation of the keys perforates a strip of paper with a series of holes. When this strip is run through the sender, electrical impulses corresponding to the holes are sent out over the line. In connection with this is used a device called a multiplex distributor, by means of which each printer may use the circuit only one-quarter of the time. During the time the circuit is not available to any particular sending machine, it stores up within its mechanism the electrical impulses and releases them the instant the line is opened to it. Revolving brushes moving over a circular commutator open the line to the printers it serves in rapid succession. At the other end of the line is another such commutator kept in exact synchronism with the first, which opens the paths to the proper receiving instruments in the corresponding rotation.

Thus each pair of wires may carry one telephone conversation, four ordinary telegraph circuits or eight printer telegraph circuits. Another half-telephone circuit is added by what is known as the "phantom circuit." This circuit is rigged up without any more wire by using the two wires of one circuit as one wire and the two wires of another circuit as though it were the second wire of a third circuit. If the electrical characteristics of the two circuits are carefully balanced it is possible to carry on the third conversation over these two circuits without interference. The "phantom circuit" does not play such an important part in local telephone service because expensive apparatus is required to effect the proper balancing and it is cheaper to lay additional lines. But in long-distance work there is a decided saving in favor of the phantom circuit and it is now universal throughout the long-distance plant.

Still another device has come into use where even these schemes fail to meet the demand for long-distance telephone lines and it is not possible at once to provide new circuits. This is the so-called carrier system. By this system it is possible to transmit over a single circuit a number of telephone or telegraph messages simultaneously. This is done by superimposing the voice current upon a current of very high frequency in such a way that they can finally be separated and diverted into separate receivers. The distant receiving apparatus is not "tuned" as in radio work, but is made selective by the use of electric filters which are quite different in principle. In this manner as many as four carrier telephone currents, each vibrating at a different high frequency, may be sent over a single pair of wires at the same time. In addition, the same wires may carry an ordinary telephone conversation and half of a phantom circuit. These, together with the ordinary telegraph circuits, make a single pair of wires available for a score or more of simultaneous messages. The usefulness of the carrier scheme is limited to open-wire lines, however, because in cables the high frequency current is readily dissipated.

It would seem that this is the very maximum of efficiency to be obtained from a pair of telephone wires, but a very simple operating scheme only lately introduced saves seconds in "putting through" calls and adds materially to the capacity of existing lines. This is called the dispatch system of operating. For each two operators at a switchboard a third dispatch operator is provided. She sits at a little table-like extension between the two switchboard operators.

Between the intervals when subscribers are not actually talking over long-distance circuits there are moments when these circuits are available to the dispatch operator for the passing of information needed to establish later connections. The dispatch operators, who are advantageously located for their task, keep the circuits busy at such times as they might otherwise be idle, and the information they receive from one another they give to one or the other of the two board operators, who make the actual connection. This saves the time of the board operators in passing information over the line, but the additional wire capacity more than justifies the use of the third operator.

Along with all of these improvements have gone improvements in testing devices, which, from the standpoint of service, are of almost equal importance. An essential part of the equipment of any modern long-distance telephone exchange is a "test board" from which trouble may be located and repairs effected or directed, and temporary circuits can be rigged up in case of breaks, etc.

If a break in a line or a crossed wire occurs between cities, the laborious and time-consuming expedient of "running down" the trouble need no longer be resorted to. A tester at his desk in a city perhaps a hundred miles away is able to locate the trouble, at least within the distance of a few poles, and is able to send a lineman to the exact spot. The tester uses for this an ingenious application of the Wheatstone Bridge, by means of which he determines the electrical resistance of the unimpaired line. Knowing the resistance of his line per mile he can quickly determine the exact distance from him of the trouble.

It is told how a certain gentleman of color recently decided to replenish his treasury by taking copper wire from a long-distance telephone line, selecting a lonely spot between two towns. By the time he had clipped three wires the test-board man had notified the police in each of the towns that someone was stealing copper, and the exact location of the thief was given them. The latter was surprised in the act of loading the wire on a wagon.

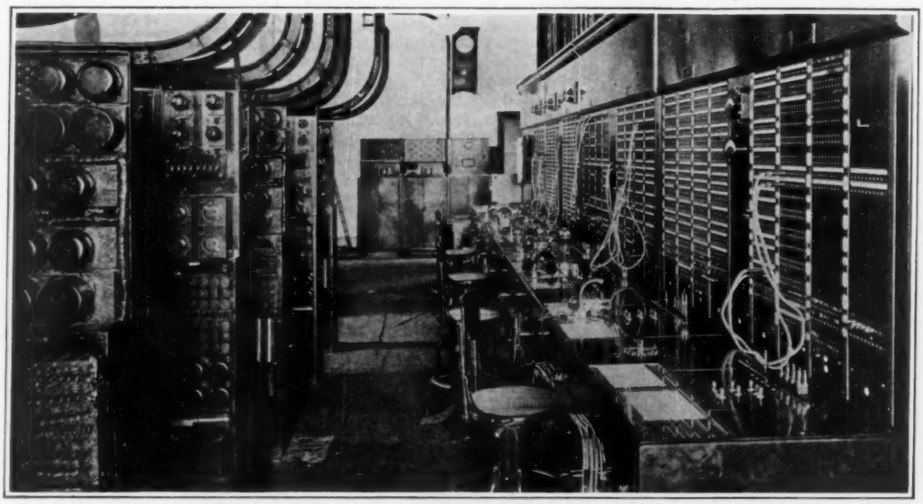
From these same test boards the lines are regularly tested for their electrical qualities and a certain standard of transmission is maintained. If trouble develops it is usually located and corrected before it actually interferes with service.

Such apparatus as we have described, and much more which has not been mentioned, nearly fills from top to bottom the 26-story long-distance exchange in New York. Here some 27,000 long-distance calls are handled every day. The net result of an inspection, to the writer at least, is a complex and dizzy jumbling of thousands of pieces of apparatus and millions of wires. And yet there is perhaps no better example anywhere of perfect harmony of effort and lack of confusion.

It is a striking afterthought that telephone engineers are by no means satisfied with the results they have so far attained. Over 3000 technically trained men are now employed in the telephone service and of these, more than 1000 are engaged in pure research, seeking better and cheaper means of communication.

View after the severe storm that swept New England during last winter, destroying hundreds of poles and making work for the "test-board" man as well as the lineman

Typical telephone troubles: The effects of snow, frost and wind, which confront the repair crews



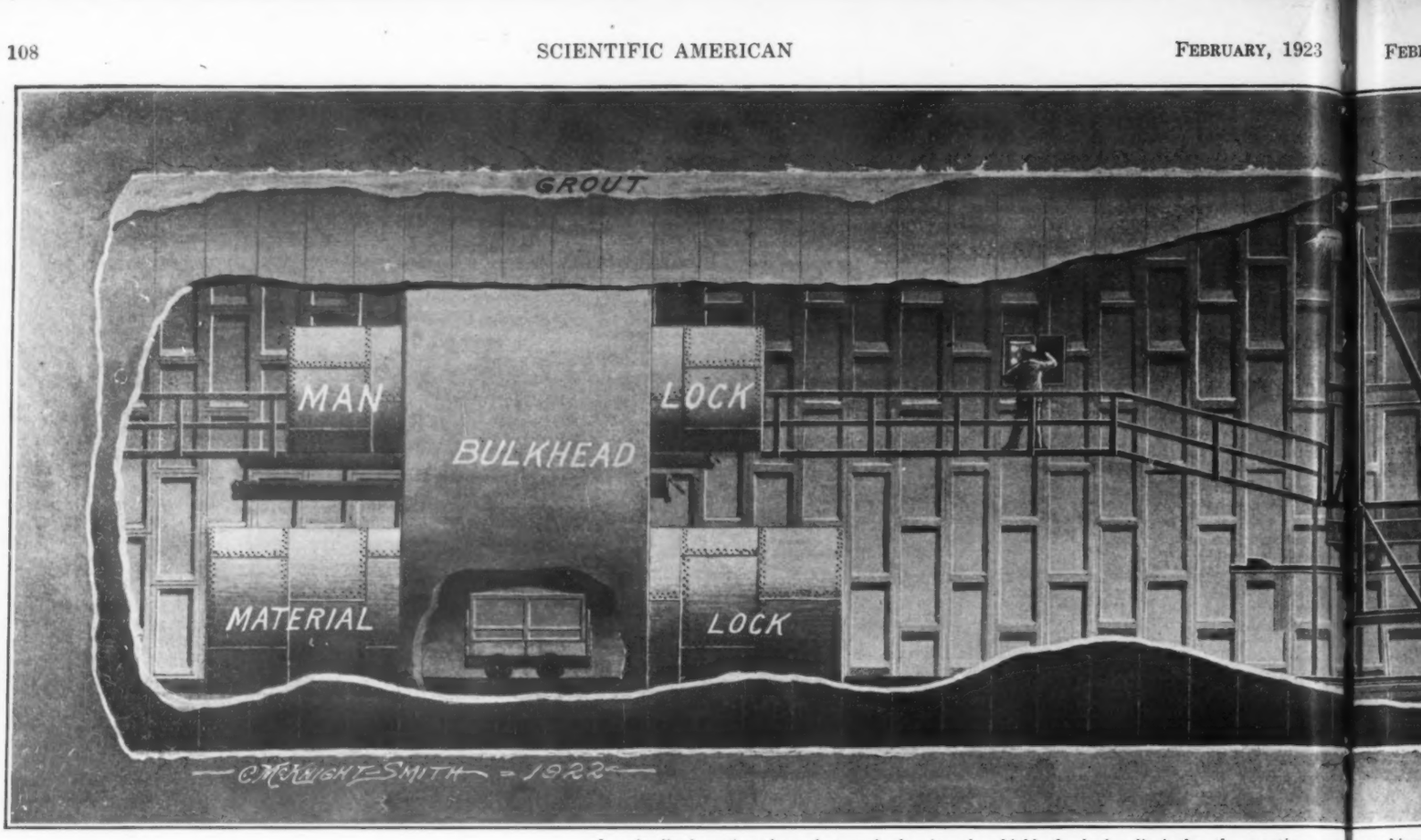
This view is of the repeater station at Princeton. Similar installations must be made at intervals of about 250 miles on all lines. On the left are the telephone repeaters employing vacuum tubes; on the right the test-boards used in testing the circuits to keep them in good operating condition

Interior of a typical "repeater" station on a long distance line

Inauguration of Aerial Service in Mexico

COMMERCIAL aviation is rapidly expanding, and thus giving proof of the increasing importance of this branch of the automotive industries. The Secretary of Communications of Mexico, according to *El Campo* of September, 1921, has made arrangements with a foreign company with a view to establishing an aerial transportation service for passengers and cargo between Mexico City and Tampico. The operating company made the first trip with passengers, mail and cargo on September 1, taking two and a half hours from Mexico City to Vera Cruz and one hour from Vera Cruz to Tampico. When the shipment of 15 machines arrives the services will be extended to include San Luis Potosi, Monterey, Laredo, and Matamoros. A special service will be established between Tampico and Laredo.

A commercial aerial service between Juarez city and the city of Chihuahua is definitely planned. The distance between the two points is approximately 360 kilometers, and the journey takes 10 hours by rail and 12 hours by automobile. The airplanes, which will be piloted by American aviators, are expected to make the journey in less than two hours. Special flights are planned to mining camps and other nearby places, with the consent of the mine owners. The landing fields in Juarez city have been chosen and permission has been obtained from the authorities of El Paso to use the field of Fort Bliss, near the frontier, for landing purposes, according to our informant.



Longitudinal section through tunnel, showing the shield, the hydraulic jacks, the erecting arm, e working

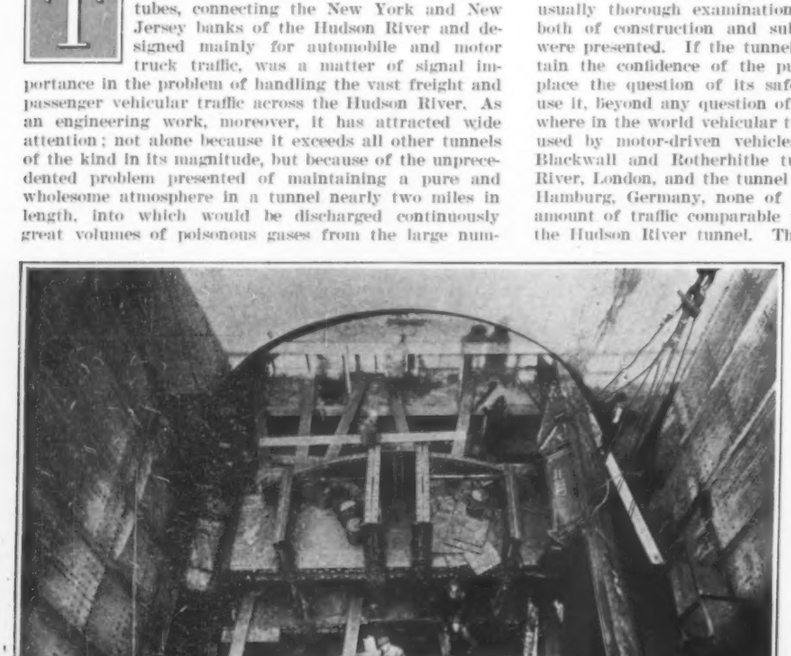
The World's Larg Veh

Construction and Method of Ven of

By J. Walker

THE COMMENCEMENT of work (Oct. 12, 1920) on the construction of two large tubes, connecting the New York and New Jersey banks of the Hudson River and designed mainly for automobile and motor truck traffic, was a matter of signal importance in the problem of handling the vast freight and passenger vehicular traffic across the Hudson River. As an engineering work, moreover, it has attracted wide attention; not alone because it exceeds all other tunnels of the kind in its magnitude, but because of the unprecedented problem presented of maintaining a pure and wholesome atmosphere in a tunnel nearly two miles in length, into which would be discharged continuously great volumes of poisonous gases from the large number of motor-driven vehicles which will use the tunnel.

The inauguration of this work was preceded by an unusually thorough examination of the special problems, both of construction and subsequent operation, which were presented. If the tunnel was to secure and maintain the confidence of the public, it was necessary to place the question of its safety for those who should use it, beyond any question of doubt; for, although elsewhere in the world vehicular tunnels have been built and used by motor-driven vehicles, as in the case of the Blackwall and Rotherhithe tunnels under the Thames River, London, and the tunnel beneath the river Elbe at Hamburg, Germany, none of those tunnels handled an amount of traffic comparable to that which would seek the Hudson River tunnel. The carbon-monoxide in the gas engine exhaust is a gas that becomes fatal if it exceeds a certain percentage of the atmosphere into which it is discharged; and it was realized by the engineers that the problem of providing means for diluting and removing these gases must be solved immediately and beyond any question of a doubt—that this question of the purity of the tunnel air was, in fact, the outstanding problem in the whole scheme.

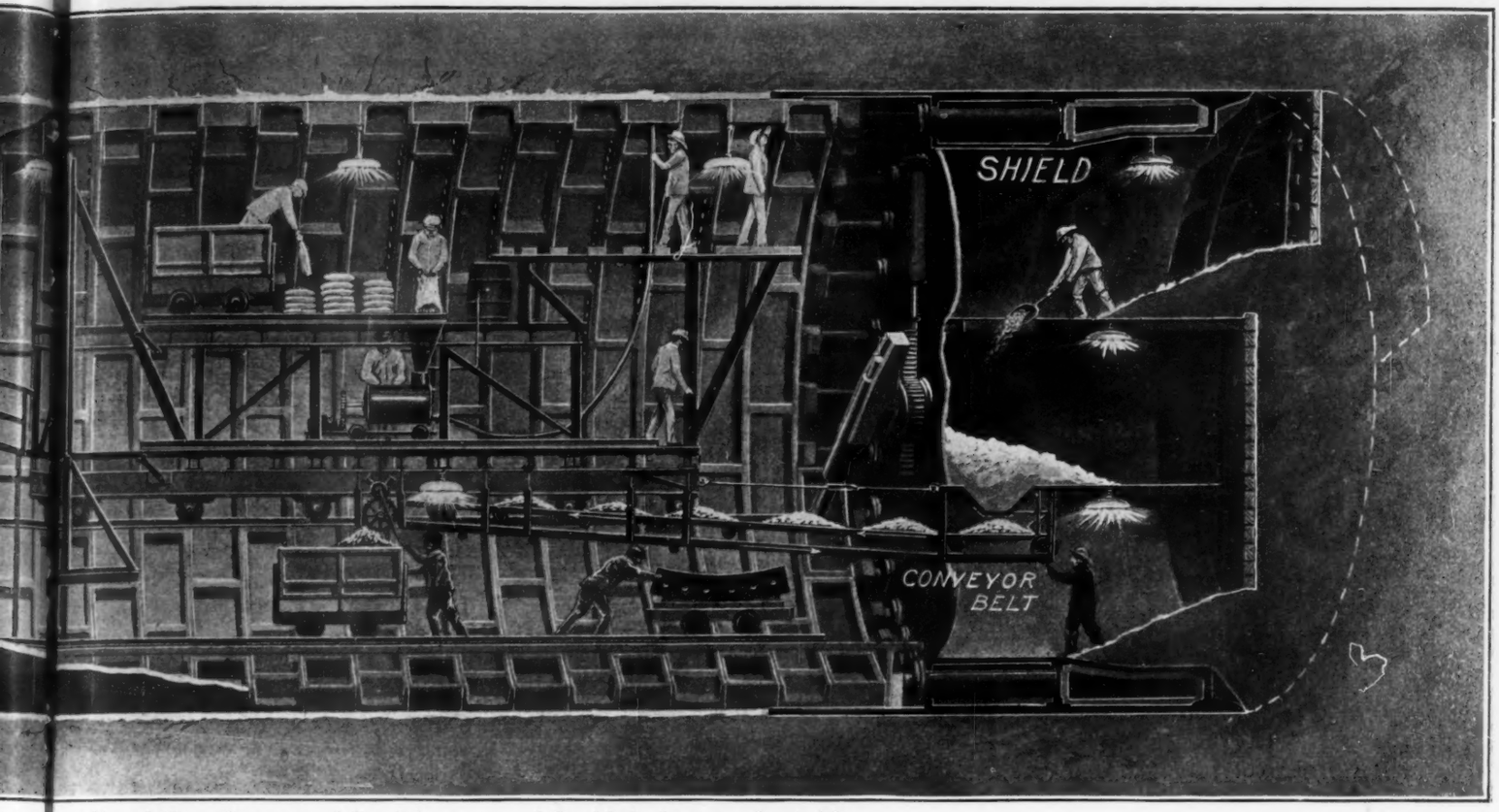


Looking down Canal Street shaft, showing erection of the shield, and the temporary bulkhead in river face of shaft through which the shield was advanced

We have described in past issues of the SCIENTIFIC AMERICAN the very thorough investigation which was carried out by the United States Government under contract with the Commission at the suggestion of Mr. C. M. Holland, the chief engineer of the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission.

There were two main problems; first, to determine re are ope amount and composition of the exhaust gases that wa located be discharged into the tunnel, and the second, to deter am of pu the proper dilution to render these gases harmless. ssues thre investigations to determine the amount and composition s the inst the gases were carried out at the Bureau of Mines Ex connected ment Station at Pittsburgh, under the direct supervi g shafts of Mr. A. C. Fieldner, supervising chemist of that statio in the and the determination of the proper dilution to render ated air exhaust gases harmless was made at Yale Univer unt of f under the direction of Dr. Yandell Henderson, consult ently is physiologist. It was upon the results of these experim e to limi that the plan and scope of the ventilating plant of usand par tunnel was determined. pletely i

It was decided to ventilate the tunnel, which meas ch will be from portal to portal 9250 feet, or nearly one and the fact quarters miles, by four vertical shafts, each provided w ections is powerful blowers for driving fresh air into the tun ity of 46,0 and exhaust fans for withdrawing the mixed air 5,000,000 gases. These shafts are located one on the land near ommencin end of the tunnel, and the other two at the pierhead line eet, New each side of the river, the distance between the la grade of being 3375 feet. It was decided that there should be ; thence longitudinal movement of the air, since this would h th of 93 involved a velocity of nearly 75 miles per hour, wit head line serious increase in fire hazard, before the products a grade o combustion were withdrawn. Instead of this, a transv t and Fou system has been provided, by which the gases will be which wi countered at once by the fresh inflowing air, and w shield m drawn locally and with the least possible delay. 6 inches, has been achieved by dividing the interior of the tun inches in by two horizontal planes, one for the roadway and ments wei other for the roof, thereby forming three separate ch t weighin bers or ducts. The central and largest duct forms each othe roadway chamber and is reserved for the traffic. by 160 provides a head room of 13½ feet and a clear width joints of 20 feet, which is sufficient for two lines of vehicles. lked, and lowest opening of the three is the fresh air duct, whi nel lining connected with the air blowers in the vertical ventila filled in shafts. At frequent intervals on each side of the road nel under



g arm, the working platform, the conveyor belt and dump cars, and the airlocks for men and materials

arg Vehicular Tunnel

f Ven on of the Hudson River Tunnel

y J. Walker

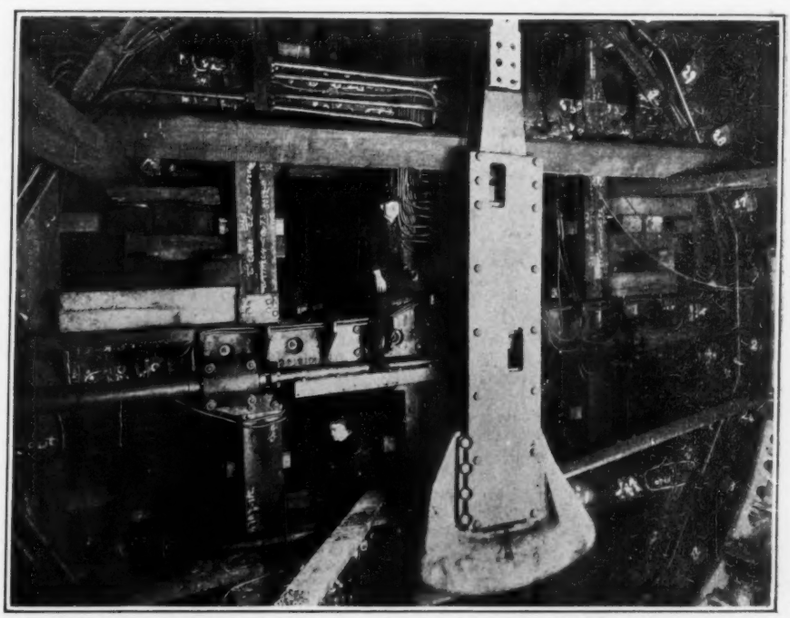
rmine ve are openings from this duct into expansion cham- hat wa s located in the curb, and through these a continuous deter eam of pure air is discharged. From these chambers less, ssues through a slot to mingle with and dilute the positi es the instant they leave the exhaust. The upper duct es Ex nnected with the powerful exhaust fans in the venti- upervi g shafts, and into this duct there open frequent t stati s in the roadway chamber roof, through which the ender ated air is drawn off from the tunnel. The total Univer ount of fresh air to be supplied to the tunnel per- consu ently is 3,600,000 cubic feet per minute, and this will perm e to limit the carbon-monoxide to four parts in ten t of ousand parts of air, a dilution which renders the air pletely innocuous. The enormous quantity of air meas ich will be poured into the tunnel is rendered necessary nd th the fact that the estimated hourly capacity in both ded ections is 3800 vehicles, which represents a daily ca- tunn ity of 46,000 vehicles and an estimated yearly capacity air 5,000,000.

ear c mmencing on Broome Street to the east of Hudson l line eet, New York, the north tunnel will pass on a descend- e la grade of 3.61 per cent until it reaches the pierhead ld lin ; thence it will extend practically at level grade, at a uild h of 93 feet for the roadway, beneath the river to the , with head line on the Jersey shore; whence it will ascend ducts a grade of 2.83 per cent to reach the surface at Pro- answ t and Fourteenth Streets, Jersey City, N. J. The tun- ll be which will be driven through the bed of the river by d wi shield method, will have an exterior diameter of 29 r. 6 inches. It will be built up of cast-iron rings, each e tun inches in width, and each ring will be made up of 14 and ments weighing about 1½ tons apiece, with a key seg- e cha t weighing about 0.4 ton. The segments will be bolted ems each other, and each complete ring to the adjoining e. Th by 160 bolts, weighing about ten pounds each. All ridth joints of the segments of the rings will be thoroughly s. alked, and any voids between the exterior surface of the whic nel lining and the surrounding silt, sand, or rock, will timat filled in with grout forced from the interior of the adw nel under high air pressure. The driving of the tunnel starts from the four vertical concrete-steel caissons which have walls five feet thick. At the bottom of these, on the river side wall, and centering with the axis of the tunnel, are removable steel bulkheads 30 feet in diameter. After the caisson has been sunk to the required depth, the circular shields are erected, and the bulkheads are removed. Driving is done by advancing the shields into the surrounding material. The first shield on the New York side has already been carried forward to a distance of 75 feet.

In tunnels of the magnitude of this under the Hudson, the total quantities run to very large figures. Thus, there will have to be excavated 496,500 cubic yards of rock, gravel and silt; the cast tunnel lining will call for 115,000 tons of cast iron, and the concrete lining of the interior of the tubes, which will average 16 inches in thickness, will call for the placing of 130,000 cubic yards of concrete. Consequently, the speed with which the work can be done, and its cost, will depend very largely upon the efficiency of the means for excavating the material of the river bed and removing it quickly and continuously from the tube. Similarly, the transporting into the tube and erecting of the 115,000 tons of cast iron lining will call for easy means of transportation and special erecting gear, if the work is to be done economically and with expedition. The same remark applies to the mixing and placing of 130,000 cubic yards of concrete lining. The means by which these results are obtained is seen in the drawing above, which shows the various active operations at the heading of the tunnel.

Because the loose material through which the tunnel is being driven is subjected to the full pressure of the river above, it is necessary to keep the front end of the advancing tunnel under a pressure of air slightly exceeding the pressure to which the silt and sand at the tunnel heading are subjected. This is done by building at a convenient distance—say about every 800 feet back from the tunnel heading—a series of bulkheads of steel and concrete, 12 feet thick, as shown in the drawing, and keeping the chamber under air pressure. In order to pass the men and the materials in and out of the working chamber, it is necessary to provide airlocks in which the air is raised from the atmospheric pressure to that of the

(Continued on page 144)



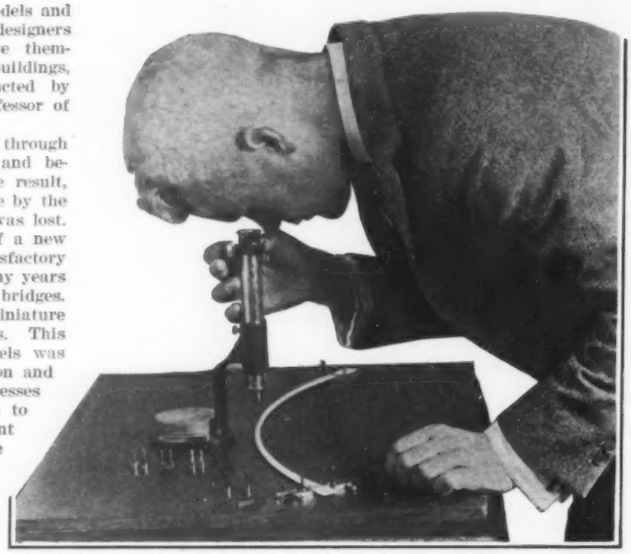
The after end of shield, showing in center the hydraulically driven erecting arm with which the segments of the casing rings are swung into place

From Paper Model to Concrete Arch

How the One Affords an Accurate Prediction of the Behavior of the Other

BY MAKING paper or celluloid models and studying their action minutely, designers of concrete structures can save themselves work and produce better buildings, according to experiments conducted by George Erle Beggs, associate professor of civil engineering in Princeton University.

Formerly, the designs had to be figured out through tedious and inaccurate mathematical work, and because of the mere approximation to the true result, due to the many simplifying assumptions made by the mathematician, much of the factor of safety was lost. The builder knew little about the behavior of a new structure until after erection. This is an unsatisfactory method; it is uneconomical, and delays for many years the refined design of concrete buildings and bridges. A better method appears to be the study of miniature models of new and desirable structural forms. This idea is not new, for the helpfulness of models was early seen by the English engineers, Stephenson and Fairbairn, who used them for the study of stresses in the Britannia bridge. Their method was to load the model until it failed. At the present time in England also, Dr. E. G. Coker, of the University of London, is making studies of the distribution of stresses in structures by the use of celluloid models and polarized light. By this method the model is loaded in the desired manner, the effect produced on the polarized light passed through the celluloid members of the structure is noted, and therefrom the stresses are determined. In the laboratory of the Ecole des Ponts et Chaussées (Paris) also recently, the calculations made for a concrete arch bridge of three hundred and twenty foot span to be built over the Rhone at la Balme, were checked by the use of polarized light acting through a small glass model of the arch.



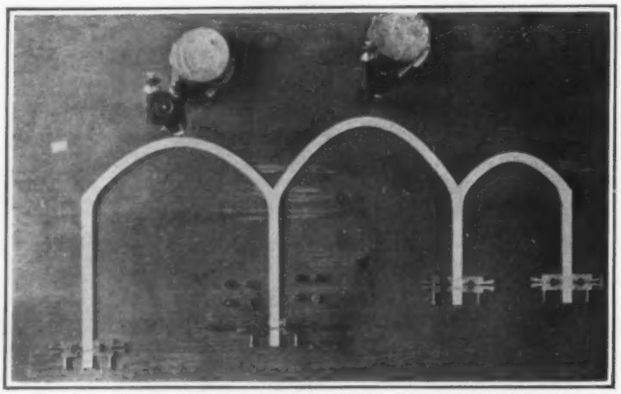
With known deflections applied to certain parts of the model, the microscope shows what deflections are produced elsewhere; and, assuming that the material of the model is of uniform elasticity, the results of this observation are perfectly general and enable the architect to predict the behavior of his structures under loads

The new method lately developed at Princeton will be briefly described. From a high quality paper about one-sixteenth inch in thickness, a model of the proposed structural frame is cut and mounted upon a drawing board. The columns at the foundations are attached to the drawing board by means of special "deformeter" gages, and the other parts of the model are supported free from the board by small steel balls, so allowing free motion in a horizontal plane. Suppose that it is required to find the vertical pressure at the second foundation due to a 5000-pound load at the center of the middle arch. Introduce thrust plugs in the gage at the second support, which plugs produce with great precision a vertical deflection of this foundation of .1000 inches. Through the micrometer microscope set up over the center of the middle arch, the corresponding deflection of this point of the model reads .0470 inches. This deflection of the load point divided by the known deflection of the support equals .47, which multiplied by the 5000 pounds gives 2350 pounds as the vertical pressure at the second foundation of the actual structure that would be caused by a load of 5000 pounds at the top of the middle arch.

There is no reason why paper should be used rather than celluloid, wood, or any other specified material. It is necessary merely that the substance selected have a constant modulus of elasticity within the very small range of stress produced by the small deformations applied to the model. If this coefficient be truly constant, the *distribution* of stresses is, of course, independent of its actual value.

Many experiments in the laboratory at Princeton have demonstrated that the analysis by elastic models is a practical method of solving the most difficult problems in concrete structures. If the designer may be assured of the strength and uniformity of the concrete, the hope may be expressed that in the future American engineers will be more ready to mold the most adaptable of materials—concrete—into a greater variety of stiff, strong, and economical structures than have yet been conceived or attempted. Our foreign contemporaries, for whom the cost of materials is comparatively high and the cost of labor low, before now have been forced to use their advanced mathematics to refine their designs of concrete structures, and the effect is enviable. The illustrations of commercial buildings recently shown to us will bring home to many American engineers our own shortcomings. In the United States, with our abundance of materials, we have become wasteful to an excessive degree, and so have failed to attain the beauty of design that accompanies true economy and a more thorough study of stress distribution.

IN early days, before the laws of physics were embodied in working formulae, the architect and the engineer made free use of small-scale models to test the strength of their intended structures. There is reason to believe that the medieval builders made use of this method in the effort to gain an approximate idea of the way their piers, abutments, and arches would act under their heavy loads. In the present article, Professor George E. Beggs of Princeton University describes the use of elastic models in conjunction with refined methods of measurement, as a practical method of solving the most difficult problems in concrete structures.—THE EDITOR.



The way the model is mounted on the drawing-board for a test

What Life Is

A LIVING animal organism is characterized by the following capabilities or powers:

(1) It can feed, that is, assimilate to itself material (food) chemically often quite unlike the composition of its own tissues, for cannibalism is not exactly a common custom. This digestion and incorporation involves excretion, or the getting rid of material useless or injurious to the organism. The one word "metabolism" covers all the changes wrought on matter by a living being.

(2) It can transform the potential energy of food into the kinetic energy of heat (animal heat), movement, nerve-energy and electric current. A living organism under this aspect is an energy-transforming machine.

(3) It is able to resist infection and, within limits, all agencies tending to compromise its integrity. It can manufacture anti-bodies, as they are called; they are biochemical responses to biochemical insults.

(4) The living body has a life history; it has birth, youth, prime, senescence. In other words, it goes through an orderly sequence of irreversible phases. Every living thing springs from an egg or ovum, which, being duly fertilized, enters on a course of evolution or progressive unfolding of its tissues from the simple to the complex, from the few to the many, from the immature to the mature. The living being is never stationary; it has time relations. It is interesting to note that amid this constant change of material, the personality or identity of the organism is maintained.

(5) Finally, it can reproduce itself; clearly all organisms that are to survive must be capable of reproducing their like. Except in the lowest forms, where buds can be cast off and thereafter attain to the likeness of the parent (asexual method), the method is the sexual, which requires the congress of two physiologically different individuals, the male and female parents, from whom proceeds the new organism.

None of these things can a dead organism do; it cannot feed, nor excrete nor produce heat; it passes through no sequence of events, it cannot reproduce itself; and finally it putrefies. Death, then, is the permanent impossibility of exhibiting the characteristics of vitality; it is an irreversible state.

Livingness is exhibited not only by entire organisms but by their constituent tissues and cells. For tissues and cells can feed, excrete, produce heat and electric current, give rise to anti-bodies, and, finally, produce new elements. The reason for the life of the entire individual is that each of its ultimate constituents is alive.—Abstract from article by Professor D. Fraser Harris in *The Scientific Monthly*.

A Voice of Five Octaves

AT a recent meeting of the Austrian Society of Experimental Phonetics in Vienna, Dr. Réthi presented Mr. Michael Prita, 44 years of age, whose voice possesses the remarkable range of five complete octaves. The deepest note uttered by this singer was a bass F corresponding to 42 vibrations per second and two octaves lower, therefore, than the deepest note which can be produced on the violin. The only previous record of so low a tone in the human voice is that of a bass singer named Fischer, who lived in the early part of the eighteenth century. Mr. Prita also rendered upper C with its full artistic value. Beyond that the notes passed into the head register and into a falsetto resembling a soprano. The highest notes emitted were the upper F (demi-semi-quaver), and on exceptional occasions upper A (demi-semi-quaver), corresponding to 1740 vibrations per second, which is one note higher than the highest sung by Patti. After the exhibition of Mr. Prita's remarkable voice, Professor Réthi made some observations upon the structure of the larynx and the noteworthy breadth and comparative shortness of the vocal chords. The phonogram, or graphic voice record produced by the singer, will be preserved.

How Electricity Causes Death

THERE are two general opinions regarding the mechanism of electrical death. Up to very recently it has been held quite commonly that death is produced by strong electrical currents, by that part of the current that flows through the heart and stops its regular functioning. However, what really happens, while not known exactly, but which still appears much more likely, is that the heart ventricle is vibrated or dilated; the expansion and contraction of the ventricles take place very readily as a result thereof, while the auricles of the heart continue their rhythmic action. The vibration of the ventricles results in stopping the flow of the blood stream through the body, so that the important organs of the body, whose continuous functioning is essential to life, are actually suffocated for want of blood.

A new theory of the mechanism of death by electricity has, however, been gaining considerable popularity during the past few years, and this theory holds that death by electricity is but one of the forms of the so-called "apparent" death, in all or in the majority of cases. The strong electric current coursing through the body, paralyzes only the respiratory organs, and if the victim is not given immediate first-aid treatment through long enduring and suitable methods of resuscitation, the condition of apparent death changes to one of actual death. It has also been maintained that vibration of the ventricles of the heart is never produced in actuality through electric shock either in man or in animals, and that this is nothing else but a mere unsubstantiated assumption.

The important feature of the new theory regarding electrical death is that when the proper means of resuscitation are taken, after the electric shock has occurred, relief can be secured in all cases. While such a statement may appear of theoretical value only, and while there may perhaps be many instances cited of its apparent inaccuracy, nevertheless it is without a doubt of great practical value. For it leads to the conclusion that hope should never be given up in any case of electric shock and that it is possible to afford the victim relief if the resuscitation is begun immediately after the electric shock has taken place.

Recently a very exhaustive investigation was made of the mechanism of death by electricity by Professor Borrutau of the University of Berlin. He found undoubted proof of the fact that the electric current, in coursing through the body, produced vibration effects in the heart and resulted in death thereby. However, while in the case of smaller animals it was possible to remove the effects of the vibration again—this was accomplished by repeated passage of the electric current through the body—in the case of the larger animals and man, this could not be accomplished; there was consequently no means available for preventing death.

The proof of this theory was afforded through numerous individual tests and electro-cardiac diagrams obtained therefrom. Similarly an investigation of numerous accidental electrocutions led to the conclusion that death occurred in such cases through paralysis of the heart. In 214 cases there was sufficient data available regarding the mechanism of the electric death. In about half of them such a condition was certain, in 82 it was probable that the current had passed through the heart, while the passage of the current through the head, consequently through the respiratory centers, did not have sufficient effect to cause death.

As far as resuscitation of victims of electrical shock is concerned, Professor Borrutau holds that artificial respiration has no effect on the heart which has been coursed by the current and subjected to the resulting violent vibration. On the other hand, it is possible to obtain relief through other means. The chest cavity must be opened and the heart may be caused to beat once again by massaging it between the hands. The process may be simplified by opening the abdominal cavity, so as to be able to massage and knead both the heart and the diaphragm at one and the same time. Of course, for practical purposes this method of resuscitation is not very expedient, for it requires the entire equipment of aspetic surgery to carry it out, and in most cases the method cannot be applied until too late after the accident has taken place.

However, experimentation and investigation have revealed that there are more practical means of resuscitation available. The electric current, which produced the apparent death in the first place, is, strange to say, used again to bring the victim back to life again. The vibrated heart is made to beat once more in normal fashion. Of course, the resuscitation current is not of the same kind as the current which caused the electric shock. Resuscitation takes place through the medium of a high-voltage alternating current, which itself does not possess the property of causing vibration in the heart. Likewise, the single discharge of condensers may be used for this purpose.

Similarly, the conclusion is reached that apparent death, produced through electric shock, may be remedied through other means. Artificial respiration is recommended for this purpose. If the victim has not been left long after the electric shock has occurred, such a procedure may result in success. There are cases reported where life was brought back after five-hour long artificial respiration. It is to be hoped that further experimentation will be made along these lines to develop a method of resuscitation, which may be applied with success in the great majority of cases of electric shock. It is of prime importance that the method be simple and easily applied, involving no great amount of apparatus or equipment, and that some aid be rendered the victim on the spot where the accident occurred. The comparatively large number of cases of electric shock makes such a development of great importance, and it is to be hoped that more attention will be paid to this matter.

A Safer Way of Bleaching Foods

THE PUBLIC demands bleached foods. When the housewife buys edible gelatine, she expects to get a perfectly colorless product, otherwise she will not purchase the product. Similarly, white cherries, peaches of perfect color in tins, pure white dried potatoes, syrups, cereals, apples and many other fruits and vegetables and other foods, either in the fresh or the dried state, are required to possess definite characteristics of color which can be secured only by subjecting the food to a bleaching process.

Consequently in bleaching their food products, manufacturers are simply complying with the public's request. When the bleaching is done properly; that is, when there are not introduced into the food any deleterious substances of mineral origin mostly, which cannot be removed subsequently, then no harm is done to the food by the bleaching process. A perfectly colorless gelatine is just as good food and possesses the same food value as gelatine which has not been put through the bleaching process. The same is true with other foods, for the coloring matter or surface blemishes that are removed in the bleaching process are generally of no particular food value, and a properly conducted bleaching process merely removes the color, etc., but does not change the food in any other way.

Sulfur dioxide, the fumes that are obtained by the burning of sulfur, has had considerable vogue as a bleaching agent for foods. Sulfur is cheap, the fumes are easily produced and are very effective in destroying the colors, etc., in the food. But there has always been a serious defect in the sulfur-fume process of bleaching. In spite of the fact that the gas and the salts that are formed by the sulfur dioxide in the bleaching process are very soluble in water, nevertheless once a food has been bleached in this manner it is almost impossible, from a practical standpoint at any rate, to wash out the sulfite salts from the food. Furthermore, inasmuch as both the Government in Washington and various States have enacted laws, limiting the amount of sulfite that is allowed in bleached foods, from an allowable content of 300 to 400 parts per million in the federal law to no content at all according to the food law of Pennsylvania, the removal of the traces of sulfur that are left in the food after the bleaching process became an important factor.

Up to the present time there has been no simple method of removing the sulfur after its work was done. Either the manufacturer did not try to remove the traces of sulfite or else he used very small amounts of the bleach or substituted other less effective reagents for it. The removal of the sulfur could not be effected economically by washing, for it took too long to dissolve out the deleterious salts contained therein.

But within the past few months a process was patented (see United States Patent No. 1,412,523, granted to Irving Hochstadter), in which advantage was taken of a simple and familiar chemical reaction to remove all traces of sulfur dioxide or sulfites and produce a food absolutely free from the objectionable impurities. This process makes use of peroxide of hydrogen, the common medicament found in every medicine chest, which has the power of converting the injurious sulfite into the harmless sulfate. The use of hydrogen peroxide for this purpose possesses certain peculiar advantages. In the first place, when it converts sulfite to sulfate, it itself is changed into water and oxygen gas. The water is harmless and may remain in the food or be removed by simple evaporation. The oxygen gas possesses a bleaching effect itself. Consequently, the addition of peroxide of hydrogen not only removes the minutest amounts of sulfite but it also aids in bleaching the food.

In the process the bleaching is aided and accelerated by the addition of a little ammonia. For example, in the bleaching of cherries, the initial step of the process is the same as that in the regular bleaching operation, the cherries being treated with a solution of sulfurous acid. After the bleaching has been effected, the cherries are thoroughly washed, and then treated with a 3 to 4 per cent solution of peroxide of hydrogen. Then some alkali, such as ammonia, bicarbonate of soda, etc., is added. Volatile alkalies are preferred, as they can be subsequently removed by evaporation, leaving no impurity in the food product.

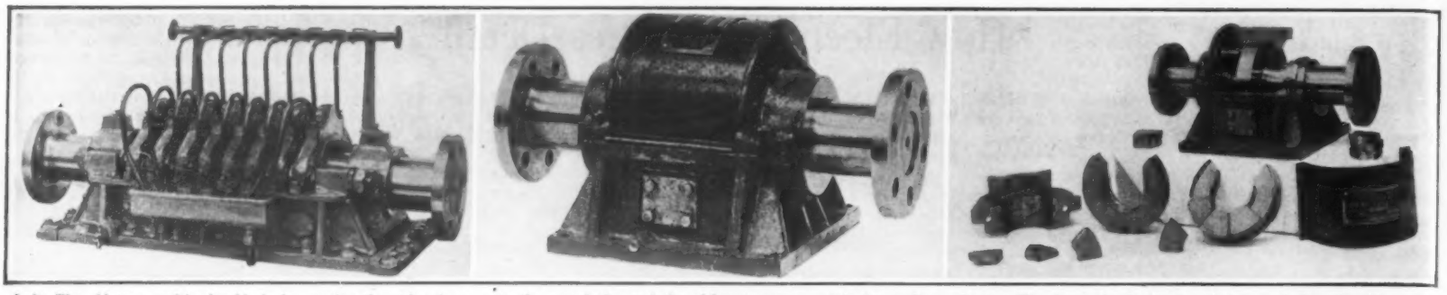
Attention must be called to the fact that the treatment of food with sulfur fumes has another effect besides merely bleaching it. Sulfur dioxide has the power to kill germs that may be found on the food, particularly in the case of fruits. It will destroy these influences which tend to cause the food to rot and protect it against future infection. In this way it performs a more beneficial function than may be suspected, and its use may be justified not merely on the ground that it does not destroy food value or injure certain beneficial properties of the food, but that it actually protects the food from subsequent spoiling and rotting. The new process, which is able to remove all the traces of the sulfur fumes left in the food, has accordingly an additional value in making possible the use of sulfur fumes for disinfection and preservation purposes.

The process can be applied to all sorts of food products that are ordinarily bleached with sulfur fumes. Syrups, gelatine, nuts, potatoes, cereals and other foods can be treated with hydrogen peroxide after the sulfur-bleaching process. Inasmuch as food will continue to be bleached as long as the public demands food products of distinctive color characteristics, this new process, in removing the traces of the bleach which have been claimed to be deleterious to the human system, performs a special service to society. It gives the public what it wants in the way of bleached food and at the same time it remedies the injury that is done to the food by bleaching, so that we can eat bleached food without any fear of being injured by the chemicals that are used to make the products.

Tungsten at Extreme Temperatures

THE September issue of the *Journal of the American Chemical Society* contains an account of the preliminary experiments made by Drs. Wendt and Irion on the decomposition of tungsten at extreme temperatures, with the production of helium. They describe fully the apparatus used for attaining temperatures above 20,000 degrees by passing heavy currents through metal wires, and state that when tungsten wires are exploded in a vacuum at such temperatures the spectrum of helium appears in the gases produced. When the explosion is conducted in carbon dioxide, 0.713 milligram of tungsten gave rise to 1.01 cubic centimeter of gas not absorbed by potash solution. The authors remark that their method "includes factors, both of cause and of error, analogous to those operative in the voluminous and inconclusive controversy on the evolution of helium in various types of low-pressure electrical discharge tubes, extending from 1905 to 1915."

The electrical apparatus provided for currents of 40 amperes at 100,000 volts during the brief period necessary to charge the condenser, which was then discharged through a tungsten wire 0.036 millimeter in diameter and 4 cubic millimeters in length. The wires were stretched between heavy copper terminals in a special spherical glass bulb of 300-cubic centimeter capacity, which was capable of withstanding momentarily an enormous outward pressure, and had a small discharge tube sealed on for examination of the spectrum of any gas produced. The wire was heated to well above 2000 degrees for 15 hours in a high vacuum before the explosion was made, and the tube before explosion showed no spectrum or fluorescence when connected with a 50,000-volt coil. No dust, smoke or solid residue was left after the explosion. Gas was present, which showed the faint presence of the strongest green line of mercury, probably from back diffusion of the pumps, and the only other line uniformly present and positively identified was the yellow line of helium.



Left: The old type multi-color block for marine thrust-bearings; note the complexity and the elaborate arrangements for cooling. *Center:* The short, simple bearing that is replacing the older one, and that requires no cooling. *Right:* The bearing shown in the center, taken apart to indicate its construction.

Old and new marine bearings, showing the application of a brand new principle

Fighting the Friction Fiend

How Invention Has Taken Advantage of the Peculiarities of the Lubricating Film

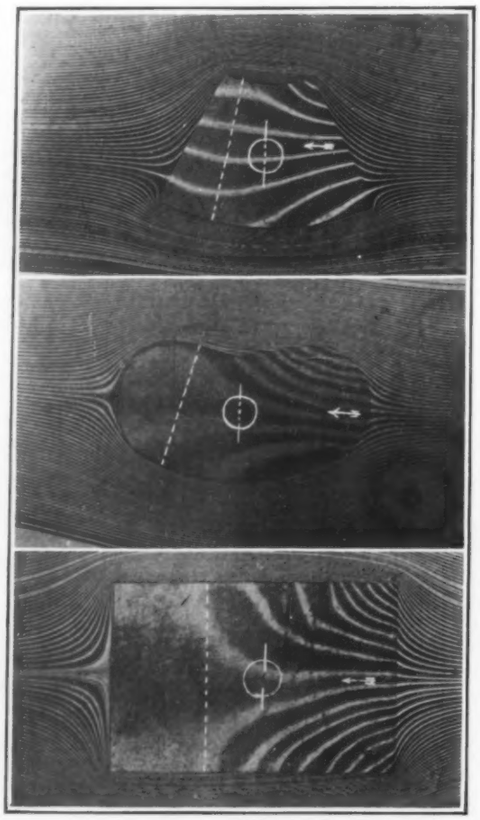
By F. Rowlinson

THE "Man with the Oilcan" is a feature wherever machinery is used. His job is to combat the insidious "friction fiend"—the cause of untold power wastage and energy loss. The absorption of energy in overcoming the friction of a multiplicity of bearings and sliding parts of machinery often amounts to from 30 to 40 per cent of the energy generated, and the only step taken to remedy the evil was, for long enough, the employment of "the man with the oilcan." By a copious and repeated application of lubricant, the friction fiend has thus been kept at bay, and not allowed to make his presence felt by hot and smoking bearings—but he is always there, none the less, continually taking his toll of useful energy. Modern research on lubricants and modern improvements in bearings have now opened up a reasonable prospect of escaping this toll.

The foundation of the science of lubrication was laid about 30 years ago, when Professor Osborne Reynolds evolved an abstract mathematical theory of lubrication which met with approval and coordinated all known facts. This theory may be condensed into the "tapered film law." It is now accepted that no lubricated surfaces can possibly be efficient unless the construction of the bearing is such that the oil between the faces is able to take up a tapered formation under pressure. That is to say, the two surfaces must be parallel and the oil must form a thin wedge between them. The ordinary journal bearing, while in a measure providing for correct film lubrication, labors under certain important disadvantages inherent in its design. These render perfect lubrication under all conditions, impossible.

If a loaded block *W* (Fig. 1) moves over a lubricated surface *A B*, scientific demonstrations show that a two-fold effect will operate to cause it to tilt slightly, so that the leading edge *B* is slightly higher than the trailing edge *A*. The entering oil at *B* may be first considered as inert along the edge *B*, and as leaving at *A* in haste to quit the pressure zone into which it has been introduced. This is the first reason why the oil film is tapered from *B* to *A*. Moreover, if the photographic views be examined, it will be seen that the oil entering along the one edge *BB* leaves along three edges, as shown by the flow lines. These photographs are of a lubricating film between a glass block and a metal surface. The oil, which has been specially colored to show the flow lines, will be seen to spread itself out fanwise. As the oil enters along *one* edge, and leaves along *three* edges, it follows that the thickness of the oil film along *BB* must be materially greater than along *AA*, if it is to be maintained. If the block be unable to lift along *BB*, then the space available for entry is only about one-third that available for leaving, and the oil escapes under the pressure faster than it can enter. The result is an increasingly impoverished film, and ultimately "greasy metallic contact" ensues. The friction absorbed by greasy metallic contact may easily be 10 to 20 times that absorbed by proper oil-film contact. The ideal condition for lubrication then, considered theoretically, is the maintenance at all times of a tapered oil film between the moving surfaces, the latter being kept apart by the wedge-action of the oil as it enters and leaves. Such a film, though microscopically thin, is remarkably strong and cannot be broken by high pressures or very high speeds. In fact, the higher the speed, the better the film, owing to its wedge-action, more effective at high speeds.

Let us see how the ordinary journal bearing fulfils these theoretical conditions. The common journal brass must of necessity be bored out some thousandths of an inch larger than the journal, for practical considerations demand working clearances which are greater than the working thickness of the oil film. The result is that the journal takes up an eccentric position, as shown exaggeratedly in the diagram (Fig. 3). The thinnest portion of the oil film occurs at *X*, and the effective thickness is maintained only from *Y* to *X*. The lower diagram shows the developed view of the film. The dotted line indicates the theoretical taper necessary in the film from *Y* to *X*; the full line shows that even over the effective surface the theoretical taper is not attained. From *X* to *A*, the taper is negative, and the pressure is negative, creating a suction effect which causes a thinning of the oil film and the eccentricity of the journal in the bearing.



Actual stream-line photographs of the flow of colored films across tapered bearing surfaces. The portions of the surfaces beyond the dotted lines are useless, and the blocks must therefore be pivoted non-symmetrically

An ordinary collar thrust bearing, as used in marine and other work, is even worse. The surfaces are necessarily parallel, and no taper can be formed anywhere. The result is a negative pressure in the whole film, and the oil is everywhere squeezed out. The friction is therefore that between greasy metal surfaces, *i. e.*, about ten times the theoretical minimum. The average thrust bearing can for this reason run only at a low pressure per square inch (say 50 pounds) and needs for heavy work a multiplicity of collars. Even at this elaborate means are usually provided for water cooling, to carry off the heat generated by the wasted energy. Mechanical difficulties also arise in distributing the load equally over all the collars.

It remained for Mr. Michell, a well-known British engineer, to provide the practical solution which most nearly fulfilled the theoretical desiderata. Michell divided the bearing surfaces into several segmental pads, each pivoted upon a center at the back. The oil then entering automatically with the rotation of the shaft, causes the pads to take up a slight inclination to the plane of rotation, so that the load is supported upon thin wedges of oil. This simple device enables the oil film to support any pressure which the metallic surfaces will carry, and experiments have shown that such a bearing will run cool under a pressure at which the white metal begins to squeeze out. As much as five tons per square inch has been carried successfully on the pads of a Michell under test. No undue heating occurred. The diagram, Fig. 2, shows two methods of pivoting the segmental pads. The point at which they are pivoted corresponds with the point of maximum pressure, and is situated a little off the center of area. No metallic contact takes place between the rubbing pads and the thrust collar, because the oil film is automatically maintained, and the pads may be said to float. The only friction generated is that due to the shearing of oil. With the ordinary thrust bearing friction increases with the load, and heating and wearing troubles are experienced if the load exceeds 50 pounds per square inch. In the Michell, the friction being that of a fluid, is independent of the load, so that 500 or 600 pounds per square inch is carried without any difficulty. These figures demonstrate that a Michell thrust bearing will carry ten times the load of an ordinary thrust bearing and absorb in friction only one-tenth of the power.

The first great application of the Michell principle was to the thrust blocks of marine propeller shafts, and marine practice in large shafts with heavy thrusts has been revolutionized. The most important bearing in a screw-propeller is undoubtedly the thrust block, through which the propeller thrust is transmitted to the hull. Hitherto this bearing has been the most inefficient and troublesome in the ship. The old troublesome multi-collar type of block has now given place in most high-class ships to the single-collar Michell, which requires little more attention than the passing glance of the engineer. No hose-pipe work is needed to keep the Michell cool, because, being scientifically designed, no metallic contact takes place between the faces, and the block does not run hot. In particular, the Michell principle has rendered possible the geared turbine drive now being used with such success. In ordinary marine turbine practice, it is possible to neutralize the propeller thrust at least partially by balancing it against the thrust of the turbine shaft—with geared drive this is impossible. In the British High Court of Justice, in

1919, Mr. Justice Sargeant said of the Michell block: "The result of this invention has been to increase to an extraordinary extent the efficiency of thrust bearings by allowing them to withstand an enormously higher pressure per square inch of surface. The evidence before me is clear and uncontradicted that with the previous type of thrust bearings it was impossible to use shafts carrying more than 3000 or 4000 horsepower at the most, and that, even then, constant attention, repair and renewal was necessary after short intervals of use, and that the use of the gear-driven turbine, as it has been practiced in the Navy throughout the war (including its use in submarines), and as it is being used in fast commercial vessels now, has been rendered possible only by the invention now in question." At the head of this article the photographs show a comparison between an ordinary marine thrust block and between a Michell block for the same service. One of the Michell blocks for "H. M. S. Hood," the largest vessel of the British Navy, carries 36,000 horsepower on a 25-inch shaft at 210 revolutions per minute. Over 10,000,000 horsepower in the British Navy alone is transmitted on Michell blocks. The new thrust block is limited by no considerations of speed. As the speed increases, the angle of the pads adjusts itself automatically to the new speed. For this reason the Michell block is in use for steam and water turbines, in the former at speeds up to 3000 revolutions per minute, with normal load pressure of 400 pounds per square inch. This efficiency is unapproachable by any other method.

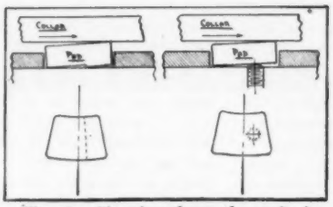


Fig. 2: Showing how the principle of the tapered film is applied practically in the Michell block

For ordinary journals, the Michell principle has been applied in a similar fashion. The author has records of a case reported by a tyre cogging mill, in which the ordinary bearings of phosphor bronze lasted only 2 to 3 hours, when they needed grinding up and replacing. With the installation of a bearing on the new principle, the bearing has been free from trouble, and requires no attention whatever beyond a small quantity of oil. Engineer Vice-Admiral Sir George Goodwin, Engineer-in-Chief of the British Navy, has said of the new principle of lubrication of bearings: "To be quite candid, it is probable that the bearing-metal problem has lost a great deal of the importance that formerly belonged to it, owing to the fact that the true principles of lubrication so long known but not utilized have now been applied in a manner which can properly be described as revolutionary. It has long been thought that the nature of the bearing metal itself was a minor matter, provided that the oil film between the rubbing surfaces could be maintained; and the problem before engineers for years has been how to maintain that film, with the ever-increasing direct bearing pressures and rubbing velocities. Following the mathematical investigation of the problem by Professor Osborne Reynolds some years ago, the practical solution of the problem has been effected by Mr. Michell in no uncertain manner. It has been adopted unreservedly in the Navy for the thrust blocks of all descriptions of engines with complete success. Although some difficulties have presented themselves in the application of the principles to marine journal bearings on account of the need of reversibility, they have been overcome."

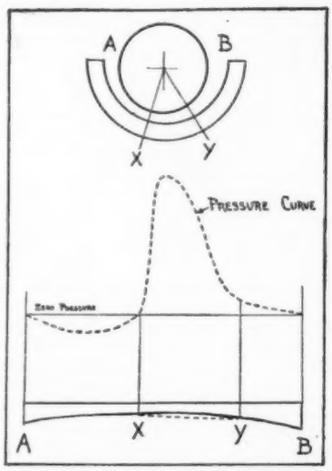


Fig. 3. Showing why the ordinary journal bearing is never fully efficient

Tens of thousands of the new bearings are in use in all parts of the world, and though at first engineers were found skeptical that so great an advance on old-time methods was possible, it is now acknowledged the whole world over that the friction fiend who wastes our time and who robs us of our energy is at last vanquished.

The foregoing method is a mechanical solution of the problem rather than one involving the use of new lubricating compounds or oils. It is well here to recall some of the remarkable strides which have been made in overcoming friction. Ball bearings and roller bearings are too well known to require much explanation. Certain alloys have been introduced which give excellent results when used for bearings. One of the most interesting developments in reducing friction has been the development of graphited metal, such as brass. By an ingenious method it is possible to impregnate brass and certain other metals with graphite that permeates every little pore, so that an absolutely smooth, self-lubricating surface is produced, which requires no oil. Another interesting development is an alloy which indicates by its color if it is properly cooled, by means of ample lubrication, or if it is getting hot. Bearings made of this metal must of course be used in an exposed position, where their indicative properties can be employed to good stead at all times.

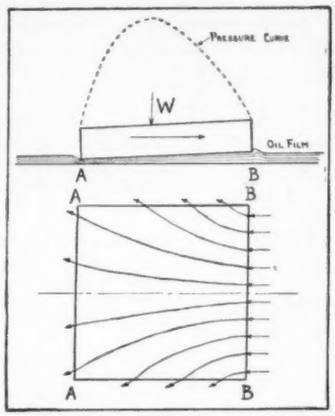


Fig. 1: Showing how the tapered film law of lubrication acts, and the flow of a tapered film under a bearing block

Construction of a Steam-Turbine Wheel

By John K. Cochran

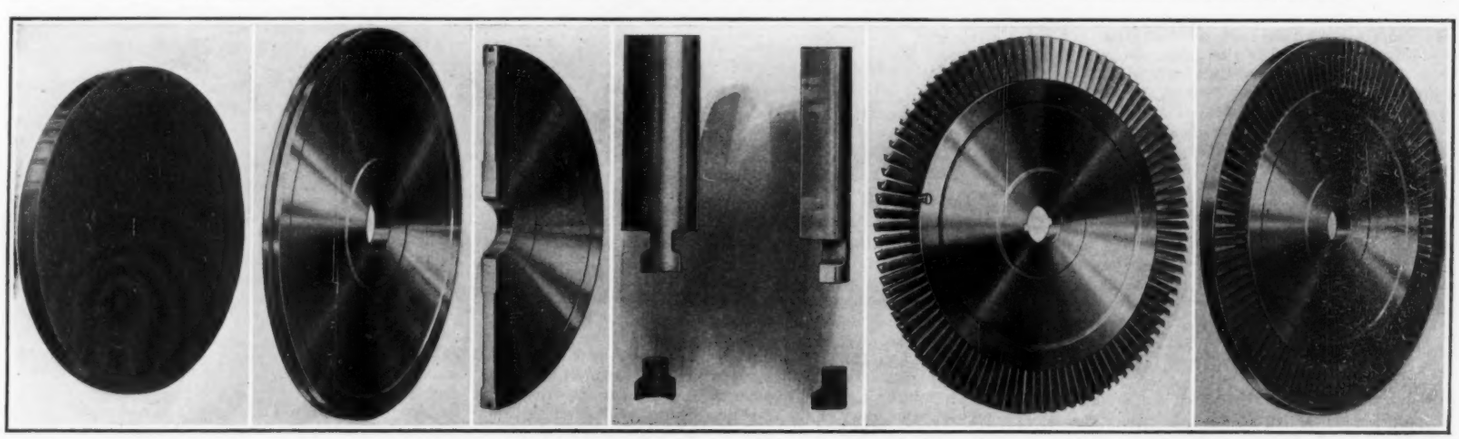
TURBINE designers today are tending toward lower wheel-speeds and elimination of the extreme gear-reductions of former practice. But even under these less severe conditions, the demands upon the wheel are heavy. The impact of the steam on the blades tends to wear and pit them; but the buckets must remain clean and "slippery" and must be able to withstand the shock when the steam is turned on.

The wheel proper is turned from a blank of open-hearth steel, and so far as it is concerned itself, can withstand anything in the way of centrifugal strains likely to happen to it. But the buckets provide another problem. If these are cut from the blank itself, their blades are in a horizontal plane, and centrifugal force works on them at an angle of 90 degrees, tending to straighten them out so that they will be along a radius line. If this is to be avoided by placing the bucket the other way, it is necessary to make them separately and fasten them around the wheel. The problem of their composition is not so difficult. Monel metal has been used extensively, and there are other non-corrosive, rust-proof metals on the market that will give satisfactory strength as well. But the problem of attainment is still to be met.

The buckets must be so placed on the periphery of the wheel that there is a permanent lock. Speed must not affect the locking qualities between the bucket and the wheel proper, and there must be no strain placed upon the buckets at the point where they are locked. Our illustrations show one very interesting way in which these demands are met. A slot is cut all around the edge of the wheel, as shown in the second view and, in cross-section, in the third. A circular hole at one side of this slot admits alternately a bucket and a spacer such as are shown in the fourth photograph. When the entire groove has been packed full of buckets and spacers, these constitute in effect almost one solid piece of metal, being forced tight against one another under pressure. When the hole through which they have entered is brazed over, the bladed wheel becomes a unit which can come apart only by breakage.

Around the outer tips of the buckets there is placed a continuous shroud of the same metal as the buckets, spot welded to each bucket and welded together at its ends. The purpose of this shroud is best understood by picturing a slug of condensed steam entering the wheel—a very common thing in practice. There is a violent shock on the wheel and each bucket has to take up that shock. Naturally the steam is most likely to hit at the tip of the bucket, and there is a fulcrum action which, if the bucket were free to yield to torsion, would tend to break it off at its base. But the shroud distributes the strain uniformly through all the buckets, and itself takes up a goodly part of it.

With such a wheel, hot-pressed on to the turbine shaft, there is a big factor of safety for every hazard of turbine operation. The objectionable features of an entirely solid steel wheel are removed, yet strength far superior in every respect is attained, with points of excellence impossible in an all-steel wheel.



In order from left to right, these views show: the steel blank; the latter with the annular groove cut for the reception of buckets and spacers; section of the wheel at this stage, showing shape of the groove; a bucket (above) and a spacer (below), each seen from front and from side; the wheel with the buckets all in place, but with the hole still unbrazed through which they were inserted; and the finished wheel, with shroud welded in place outside the buckets

Six stages in the making of a steam-turbine wheel with buckets separately attached

Power From a Whip

CONSIDER the spinning top, spurred into action with the aid of a whip—a toy which every one of us has seen or used in childhood. The physics of this apparatus is shown in Fig. 1 of the group at the bottom of the page. Here *T* is the top, spinning on its axis *C*, and 1*A*2*B*3 is the instantaneous position of the whip at the moment when its point *B* makes contact with the top. The contact at *A* has been made previously. The point 3 of the whip is moving in the general direction of the arrow. The top rotates in the clockwise direction, as shown by the second arrow, until there is no more room between the loop *A*2*B* and the top.

Now suppose that the point 1 was fixed, and the top's axis fixed as well so that it cannot walk about as it spins. Then if, as in Fig. 3, the point 3 were moved back and forth with the range shown by the solid-line and the dotted-line positions, we would have a series of impulses against the side of the top, as indicated by the two positions of the cord-segment *A*2*B*; and the net result would be a steady rotation of the top about its axis.

The cord 123 can be made to behave in this fashion by the mechanism shown in Fig. 3. The tuning fork is made to vibrate (see below), and the cord *KK* is alternately stretched and relaxed. The whip cord 123 is fastened to *KK* at 3, and beats back and forth with *KK*, as indicated in the diagram. At *A* it moves very little; at *B* more; but in every case its range is so small that for each half-vibration of the cord *KK* and the point 3, the points *A* and *B* on the cord and on the top's periphery travel only a small fraction of an inch. This means that in one second, at 300 vibrations per second of the fork, we can count on a circumferential travel by the top of several inches. If in place of a mere top we have a shaft of diameter 1.5 inch, we may count on 1½ revolutions per second on the average, or 90 per minute, which is adequate for many classes of work.

Several years ago, this scheme was put into effect by Mr. A. C. Ross, of New York, in the construction of a phonograph motor. The vibrations of the fork may be induced either by alternating current in an electromagnet *M*, or by direct current interrupted by the motion of the fork itself. If the frequency of the fork is any even multiple of that of the driving current, the fork can be kept in steady vibration; *e. g.*, 60-cycle current will run smoothly a fork whose rate is 60, 120, 240, etc., vibrations per second.

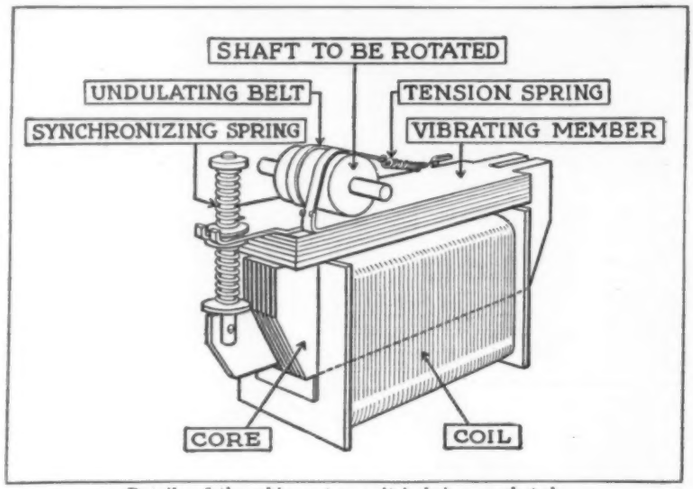
The nearer the points of attachment *K K* of the driving band are to the nodes of vibration *L*, *L* of the fork, the smaller will be the angular motion of *T* per semi-vibration of 3; but the greater will be the torque on the shaft. Large forks giving much power can be used. There is a compensating action to some extent when a given-sized shaft is driven for comparison purposes at, say, one-quarter of the prong-length, on two different forks. The larger fork has more travel but vibrates more slowly, hence the ultimate speed of the shaft is about the same as that given by a fork with twice the pitch giving twice the vibration rate, but only about half the travel.

The actual operation of this motor is a curious sight. The driving band 123, of cord or of leather, apparently lies about the shaft limp and lazy. Turn on the vibrator *M* and this band becomes as rigid as a Prussian grenadier on parade; and, apparently without moving, it commences to turn the shaft.

A more ambitious application of this same idea is now being marketed by a Canadian inventor, Leslie R. McDonald, of Montreal. Mr. McDonald hit upon the idea independently while engaged in duplicating "Melde's experiment" in physics. In this, a string affixed to a tuning fork is attached horizontally over a pulley to a small weighted pan, and the behavior of the string noted when the fork is vibrated.

Mr. McDonald calls the apparatus "the rotor," to emphasize his viewpoint that it is a radical departure from ordinary motor practice. His invention is already in successful use, having been commercially developed to a size of about one horsepower. The maximum size that can be made practicable is still a matter of conjecture. Meanwhile, the rotor has been applied in many industries where a light-weight, low-speed power unit is required. The dominant features are its simplicity and longevity (there are no brushes, no armature, no commutator); its high torque (the starting torque is ten times as great per unit of weight as that of the more conventional motor); its lightness, portability, cheapness of construction, and economy in running.

The vibrations of the tuning fork are ordinarily maintained electrically, since a source of electric current is nowadays so universally present. But the rotor is not necessarily an electrical attachment. In order to comprehend properly the working of this unit, it should be understood that the device is in no sense electrical, except in so far as the use of electricity is at present the most convenient method of maintaining the vibrations which are converted into power. If water, or wind, could be made to produce steady vibrations, the rotor may eventually give equally good results with free fuel. However, at present, owing to the elimination of all speed-reducing devices, the actual consumption of energy for a given amount of work is sometimes as low as one-fifth the consumption of the ordinary induction or repulsion type motor. Its speed is under perfect control, and the rotor cannot "burn out" on the voltage and frequency for which it is designed.

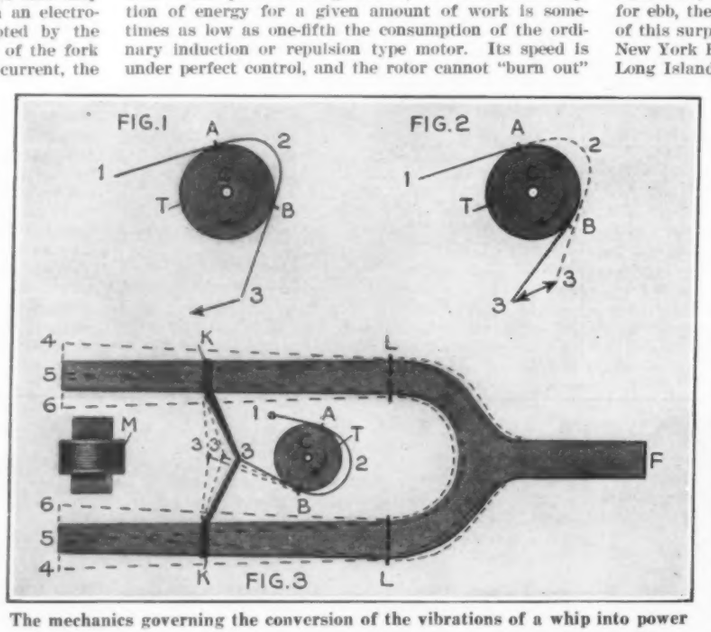


Details of the whip-motor as it is being marketed

The working of the rotor is not easy to understand, because it depends upon a principle not hitherto employed. In the rotor illustrated by the accompanying diagram, the vibrations are produced by an electromagnet. Synchronizing springs are attached to the vibrating member to give the same natural periodicity of vibrations as the electric (alternating) current. The belt, which is given one turn or more around a pulley connected directly to the load, vibrates synchronously with the vibrating member.

The whole secret of the rotor lies in the action of the belt. The belt is attached to the vibrating member at an angle of about 15 degrees from the perpendicular. The force produced by the vibrations being resolved into two component parts at right angles to each other, creates a wave motion in the belt, or a sort of "whipping" action. When the vibrating part pulls downward, the wave is at its lowest point, or in close contact with the shaft, and as it moves upward the belt is thrown upward and away from the pulley. Depending upon the tension at the end of the belt and the length of the belt, one or more of these waves is produced. The motion is more easily understood if one imagines a snake, with its tail held firmly, trying to crawl over a barrel.

Five years were devoted to the mastery of the secret which was stumbled upon more or less by accident, and to the determination of the most effective arrangement, composition, length, weight and tension of the belt. A mohair shoe-string is used successfully in some models, and after two years of continuous running shows no signs of wear.



The mechanics governing the conversion of the vibrations of a whip into power

Cleansing New York Harbor

IN the *Geographical Review* for July, 1922, Mr. S. A. Reeve has an interesting article with the title "Cleansing New York Harbor." Mr. Reeve points out that the natural cleansing action of the tides might be multiplied manyfold by the erection of tidal gates in East River at some point near Wards Island. Such gates he supposes to be operated by power, automatically set into action by the turn of the tidal current, in such manner that on the eastward flow of the tide through Hell Gate they are closed, while during the westward flow they are open. The gates would involve a problem that is not serious either from the engineering or the financial point of view, in comparison with the magnitude of the interests concerned.

Supposing such gates to be in position and operation, their closure during the flood tide would force all of that area of waterway between Wards Island and Throgs Neck, or perhaps even as far as City Island, to fill with fresh sea water from Long Island Sound instead of filling with polluted harbor water through Hell Gate, as is now the case. When the tide turned for ebb, the opening of the gates would permit the bulk of this surplus clean sea water to escape to sea through New York Harbor, instead of returning eastwardly into Long Island Sound, as it does now.

Twice every day this process would put, on the average, about ten billion gallons of pure sea water into and through New York Harbor, washing out to sea through the Narrows its accumulation of impurities. The actual amount would vary from day to day, according to moon and weather; but the average amount would be about that stated—ample for rinsing out the harbor to a state of virtual cleanliness.

Since immediate objection will be made that such pollution is not wanted in the waters below the Narrows, it is to be replied that *it all goes there now, anyhow.* There is at present no appreciable efflux of sewage or other pollution into Long Island Sound. It all goes out through the Narrows, polluting the adjacent beaches before it finally dissolves in the sea. The trouble at present is that the local pollution becomes very much concentrated before it is washed out to sea. That is to say, the beaches below the Narrows, as well as the wharves in the city and both banks of the Hudson to and above Yonkers, are now washed by a relatively stationary quantity of highly polluted water.

Under the suggested plan, on the other hand, this same amount of pollution—no more and no less—would pass through the Narrows; but in the proposed situation it would be diluted, say tenfold more than it is at present. For this reason the bulk of it would flow past the adjacent shores into deep water without finding opportunity for the deposit of sediment upon the beaches; whereas now the polluted water drifts sluggishly back and forth until the wind has had time to deposit most of its burden upon the shore. This is a plan which has a great deal of merit, and the engineering difficulties are not too great to be surmounted. It is hoped that this project may materialize.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

Scraping off old paint with the aid of compressed air

The Compressed-Air Paint-Scraper

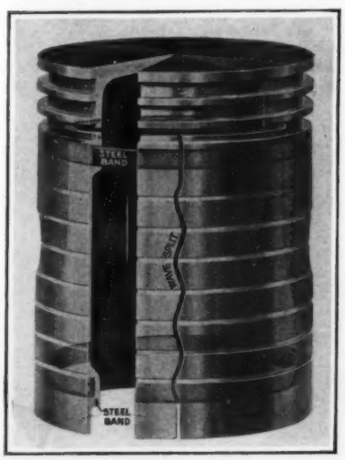
PAINT is usually removed by careful scraping, or by a burning followed by a scraping off of the burnt paint. This is tedious work, and expensive. Moreover, the burning (and in considerable measure the scraping without the burning) removes a lot of good paint. The loose paint and the blisters must be got off before the new coat can be safely laid down; but the good portion of the old coat, and that which has been absorbed into the pores of the wood, would better be left as a foundation for the new coat.

A new scraper is on the market which effects this discrimination, as well as doing its work much more quickly, easily and cheaply than the old process. It comprises a special paint scraper having a compressed-air outlet-slot on its bottom surface, about two inches from the cutting edge. This outlet is fed through a hose from a portable tank. The scraper works by simply turning on the air and moving the blade over the surface from which it is desired to remove the paint. The scraper gets under the paint here and there; the air follows and literally blows off a whole sheet of paint.

The Self-Adjusting Piston

THAT piston design is not a completed story with "finis" at the end is, we believe, sufficiently evidenced by the controversy that still rages about the aluminum piston. The piston that gives exactly the right clearance in the engine, hot or cold, under all conditions of operation, has not been attained; that is as clear as is the great advantage to be got out of such a piston. The tendency today seems to be toward eccentricity of mechanical construction as a means of approaching this ideal, rather than toward the mere use of special metals in pistons of conventional design. While we would not care to go on record as endorsing all the claims made for the piston herewith illustrated, many of these seem eminently reasonable; and the construction is on its merits of extreme interest, and quite different from any other means of piston improvement which we have seen.

The piston, as shown, is split down the skirt, from the third ring clear to the bottom. This split is in the shape of a series of waves, which are claimed to be necessary for the desired results. To prevent the obvious flexibility which is thus attained from going too far, to the point of scoring the cylinder, sturdy steel bands are cast around the entire skirt and across the split, one just below the rings and one near the bottom, as shown. These bands not only brace the split skirt, but control the expansion of the piston. Their presence causes the piston to expand at a lesser rate than the cylinder. Hence it is possible to have, in the same piston, the proper small clearance in a cold engine combined with the proper wider clearance in the hot engine.



Piston constructed to give automatically the proper degree of clearance at all engine temperatures

No strings or chains to this tobacco sack

Portable Shoe-Polishing Machine

FOR use in the home or by the shoe-repairer, a shoe-shining machine need not particularly be portable. For use in the shoe-shine parlor, on the other hand, it must be possible for the operator to carry it with him in his rounds from chair to chair; for it is not to be supposed that the business would support the capital investment that would be involved in the installation of a separate machine at each chair.

Our German correspondent, in speaking of the shoe-shine parlor, adds the words "as it is known in North and South America, Spain, and numerous other lands." We infer from this that it is not very well known in Germany. Nevertheless, a German manufacturer of electrical goods has added to his line the shoe-polisher which we illustrate—perhaps, if not for domestic trade, with an eye to export. The motor is carried in the box, and plugged into the light socket nearest the point of use. It is of moderate power, runs at 400 revolutions per minute, and attends in handsome style to the business of shoe-polishing for which it is designed.

Automatic Telephone Pad

WHEN this telephone pad is not in use it rests out of sight beneath the bottom of the telephone. By pressing the button at the side, it is shot out for use. The pad is pushed by hand beneath the telephone after use. It is housed in a disk about one-half inch thick that hugs the bottom of the instrument snugly by means of three small clamps.

The Stringless Tobacco-Pouch

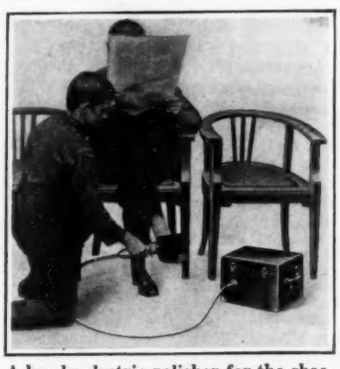
AMONG the novelties of the season is a tobacco pouch that has no strings or chains to untie or pull. The small metal guide for the tobacco, when not in use pushes back in the slide and closes it securely. The pouch is said to keep tobacco moist and to prevent much of the spilling which is so common when filling a pipe from pouches of the more conventional models.

The Surface of Liquid Steel

SOME rather interesting theories have been promulgated regarding the conditions which prevail at the surface of liquid steel, but one of the most plausible ones was made public recently by a British metallurgist in an address before a British technical society. He dismissed the phenomena connected with the surface and dealt with the question as to why liquid steel at a temperature of 1600 degrees Centigrade was able to preserve its surface unoxidized.

The authority pointed out that this was specially noticeable in steel as it flowed from the furnace into the ladle. He had previously suggested that the obvious explanation was that the vapor of the steel formed a protecting medium, but there was some objection to this theory. He therefore decided to carry out some experiments. He had noticed that sparks were given off the metal when it was being poured and also that floating above the stream was a greenish fume. He found this to consist of minute spheres which on analysis proved to be all magnetic oxide of iron. It was not easy to get pure samples of this fume because of the impurities in the surrounding atmosphere, but he did succeed in getting some samples and made observations on a complex alloy containing other metals than iron.

He found, as he had anticipated, that if the analysis of this vapor was recalculated on an oxygen-free basis, it differed in no marked degree from the original steel as regards chemical constitution. Taking a metal containing manganese, nickel and chromium, he found that the ratio of the steel from the fume recalculated to the original steel was manganese, 1 to 3; the chromium, 1 to 1.25; and the nickel, 1 to 0.67, which proved that the fume really did represent the condensed vapor of the steel and contained some of the metal in the original steel. So far as surface tension was concerned, he would like to know, he said, of some way of measuring accurately the surface tension of liquid steel, because so far as he knew, surface tension was the one real possibility of measuring the quality of steel as a solid.

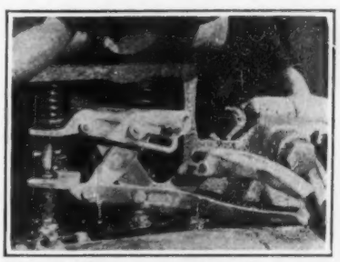


A handy electric polisher for the shoe-shine artist

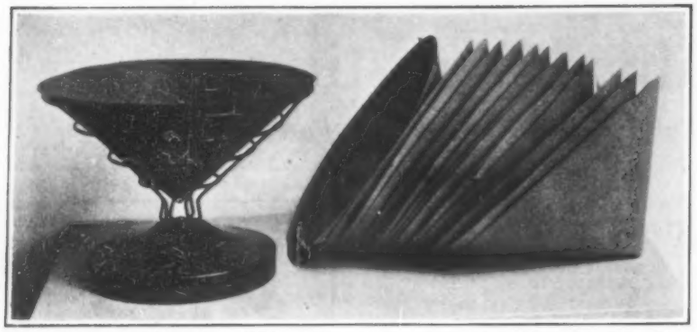
Telephone memo pad that is out of the way when not in use

A Handy Valve-Lifter

AS every automobilist knows who has ever made a serious effort to do his own repair work, one of the meanest jobs is that of putting in the valves and taking them out. Numerous alleged valve-lifters have been offered, but we have not, until the present moment, seen one that the amateur could use with sufficient facility to justify him in comparing his work with that of the professional. The one illustrated, however, seems perhaps to fill the need. It is, in construction, a parallel-jaw pliers—with one reservation. Its parallel sides separate on compression of the handle, and move together as the handles are moved apart; hence its extreme adaptation for the valve-lifting operation. Moreover, there is a very neat little lock which takes hold automatically when the jaws have achieved their widest separation, and frees thereby both hands for other



Valve lifting is reduced to its simplest terms with this modification of the parallel-jaw pliers



A sanitary cuspidor that eliminates a very nasty part of the cleaner's job

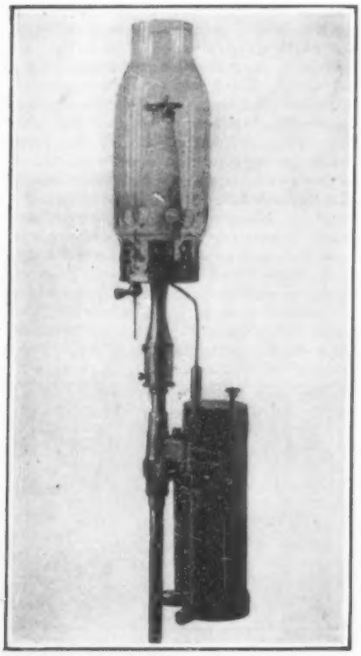
duties than that of holding the lifter in place; and which, in spite of its very positive action, is very easily tripped for release again. The instrument is made in a small size for the flivver, and in a larger model that serves for practically any other car with poppet valves of conventional L-head design.

A Greenhouse Tool

THE curious implement illustrated is especially designed for use in green houses and among flower boxes and plants. It consists of an eight-inch handle and two interchangeable blades, with a universal joint at the end of the handle, making it possible to adjust the handle to any angle, in a few seconds, and to lock it there.

The Light That Lights Itself

NUMEROUS means have been tried out for discharging the functions of the lamp-lighter, and in fact in most cities the quaint figure with his torch no longer tramps the pavements in his round from lamp-post to lamp-post. A French concern has just put out a rather clever semi-automatic device for utilizing the pressure of the gas in the pipes, in connection with the lighting and extinguishing of the burners. A pilot light with an independent feed-line burns continually, ensuring that the lighting and extinguishing of the main burner shall depend only upon the presence or absence of a flow of gas. When the gas is not flowing, it accumulates, in one type of the device, until it reaches a certain pressure, the time that will be required for this being the time during which it is desired that the light remain out. In another type, the gas is cut off at the source and turned into the mains again when illumination is desired. In either event, the pressure of the gas operates a very clever cut-in and cut-out float.



The automatic lighter for street gas-lamps

The garden tool for use in tight corners

In the first-named type, provision is made for extinguishing the light at the proper time by accumulating a small fraction of the gas that flows, until the necessary pressure is again built up; and, as in the lighting operation, it is the time necessary for this that is regulated so as to give the desired interval. The regulating device is small and compact, being enclosed entirely in the sheet-metal cylinder shown below the burner in our photograph.

Bumper for Noisy Doors

A RUBBER silencer is one of the newest ways for taking the noise and slam out of doors. It in reality is a bumper. A solid strip of rubber has holes provided in each end, these in turn slip over the knobs of the door, keeping it in place ready for the door slammer. For offices, hospitals, nurseries, this should be a means of quieting a noisy door. For ventilation purposes it keeps the door partly closed yet providing a slight draft of air.

Non-Sinkable Barge of Balsa Wood

A NON-SINKABLE barge has recently been built by Captain Whitelow of San Francisco from balsa wood, which is more buoyant than cork. It is equipped with two gasoline engines which drive the barge and operate the winches used in salvage work. The balsa wood was obtained from life preservers purchased from the Government. These life preservers were fastened together and filled in between with pitch for the purpose of holding them firmly together. In order to make the barge still more buoyant 38 air tanks have been placed at various points throughout the barge. There are three holes in the deck, which act as a self-baler, and a large hole down through the center of the deck for lifting sunken objects, a chain being passed down through this hole and operated by a winch, just as though it were located outboard.

A Sanitary Cuspidor

THIS sanitary cuspidor has a heavy metal base with a coil to hold a waterproof receptacle. The latter is made of heavy waterproof paper which can be replaced and burned.

Doctoring Sick Cylinders

BY the use of this automobile hone, cylinders can be resized and honed in the engine without taking down the motor. This means that the work of re-assembling is saved which means a saving of much time.

The device is electrically operated. The stones used in the hone do the work much better than other re-boring or re-grinding processes. The abrasive of the hone is very fine and even resulting in a smooth finish to the cylinder. The stones are eight inches and bridge the entire area of piston travel, grinding down first the unworn ends of the cylinder walls, then honing the entire length until all traces of scoring, ring travel, and out-of-roundness and taper disappear.

A Separate Road for Trucks

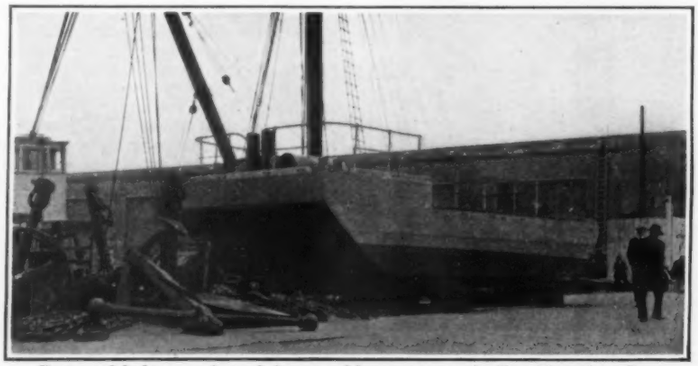
CONNECTICUT is attacking the problem of motor-traffic-congestion from a new angle in its plans for the enlargement of the Boston Post Road between Bridgeport and the New York line. Instead of widening the existing roadway, an altogether new and separate right-of-way will be graded and paved; passenger traffic will be confined to the old road, and trucks will be required to use the new one. The cost of the new road will be about a million and a half, and much greater advantage is expected from the separation of the traffic in this fashion than could be got from accommodating a single highway to it. The discrepancy in speed between the truck and the passenger car will be less felt; and at the same time either road will in emergency be available as a detour for the other. Incidentally, recent experiences impel us to the pious hope that, in the absence of passenger cars to act as pilots for them, the trucks will be driven to the use of proper head and tail lights.

Rubber bumper that takes the noise out of slamming doors

Handy tool that rebores and hones engine cylinders

Muffler Should Be Taken Apart

A PART of the chassis that is often overlooked in the overhauling and one that has material influence on the power output of the motor is the device used for muffling the sound of the exhaust. The internal construction of mufflers varies widely, some consisting only of simple chambers connected together to form a labyrinth for the gas passage and reduce the noise by breaking up the volume and allowing the gas to expand before it reaches the air, to more complicated forms having a large number of baffle plates or partition walls pierced with numerous small holes. The most effective and silent type of muffler is generally the one that will give trouble first. It is important, therefore, to take the muffler apart and clean out all accumulations of soot or burnt oil that may clog up the gas passages. Mufflers are easily taken apart, usually being held together by long through-bolts in those forms where the muffler consists of a number of cylindrical shells of varying diameter held between cast end-plates used to support the shell. Even in forms where a large number of chambers are provided these being adjacent, the muffler is held together by bolts or by being assembled on a central member, usually a continuation of the exhaust pipe. After the muffler is taken apart all carbon and burnt residue should be scraped off and all the parts of the muffler thoroughly cleaned with kerosene before assembling. It is also well to go over all the holes designed to break up the gas with a sharp punch or fine taper reamer to make sure that these have not been reduced to less diameter than they should be by accumulations of burnt oil or carbon.



Barge of balsa wood used for wrecking purposes in San Francisco Bay

The latest style of metal-spraying pistol

Recent Advances in Metal Spraying

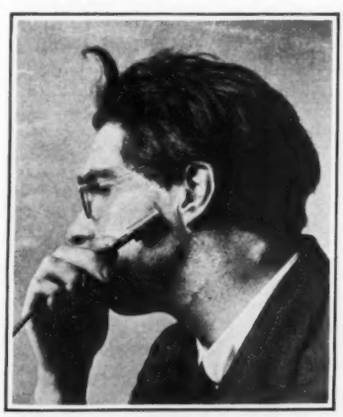
WE are informed that the past few months have seen notable improvements in the Schoop metal-spraying process. It is now possible to melt lead, zinc, tin, aluminum and copper for spraying without the use of concentrated oxygen, and to carry out the spraying with no other agents than acetylene and compressed air. Hence it is no longer necessary to transport the heavy flask.

Another interesting achievement is Schoop's success in spraying a coating consisting of quartz and glass. More recently still he has found it possible to make coatings of glass-and-metal mixtures—coatings which have extraordinary resistance to chemical action of all sorts. Numerous glazes and enamels may be substituted for the glass.

Perhaps the most important of all the recent advances, however, consists in the ability to spray a coating of stainless steel over a base of ordinary, and cheaper, metal. This mere statement is so extremely suggestive as to call for no interpretative comment.

The Voiciphone

SCHOOL children talk badly by coming into contact with other careless talkers, perhaps from indifferent homes. They get so used to hearing themselves talk that they do not notice the defects in pronunciation, etc., which, however, are very marked and noted by others. Habits of bad talk stick to them for life and handicap them in the future. It occurred to a London schoolmaster that if he could make the little ones hear themselves as others heard them they might, for sheer shame, try and improve their speech. He invented the voiciphone, which is quite a simple piece of apparatus and has been used with beneficial effect. It consists of a mouthpiece from which two tubes lead, one to each ear. The wearers when they speak into it hear their voice so magnified that all the defects are much exaggerated; and as little extraneous sound is heard, all the attention is devoted and concentrated on the voice being heard. The dropped "H," for instance, is very noticeable; and slurred sounds stand out prominently. It is said that a lesson of 30 minutes a day with the voiciphone has done more to correct speech in schools than months of argument, instruction and punishment.



"Mowing" the face is brought up from slang to reality by this electrical razor

Menace of Auto Tubes as Life Preservers

THE passage of an ordinance to forbid the use of motor inner tubes for use as beach life buoys by the city of Hermosa Beach, Calif., calls poignant attention to the fact that such "life preservers" are in reality dangerous decoys.

The California beach city maintains a corps of fifteen life guards who have entered so many complaints against the use of motor tubes in the surf that the ordinance forbidding their use is the result. Several drownings, and near drownings, have been attributed to their use. Salt water decomposes the rubber, it is said, and at the critical moment the bather finds that he is at sea upon his own resources—in many instances even unable to swim. In certain instances bathers have ventured far from shore buoyed by such improvised floats, only to have the tubes collapse, leaving them to drown, or be saved by the life guards. Another danger to such use of the tubes is pointed out in that many bathers go into the surf resting on the inflated rubbers in such a manner that they are easily dislodged by heavy waves. The great buoyancy of the tubes is said to be responsible for this. When this occurs the bather is usually violently ducked. The tube has also been known to burst when the bather grasps it, tearing away the rubber which has been rendered fragile by the action of salt water. The use of motor tubes at all the western beaches has become quite general this season, and the Hermosa warning is a timely one.

Teaching children to speak correctly by making them listen to their own mistakes

The Rotary Razor

AN ingenious novelty from England is an electric safety-razor that operates in the style of a lawn-mower. The blades are rotated within the sheath by an infinitesimal motor; and the current is cut on and off by pressing the button on the end of the cylinder. Our correspondent assures us that the inventor shaves himself with this razor, and does it well; which ought to be sufficient testimonial.

A Cam-Action Tire-Carrier

AMONG the interesting inventions which we have to chronicle this month is a tire-carrier developed by Dr. J. C. Jones, of Brookline, Mass. From the circular central disk radiate three arms, each terminating in a jaw of the proper width to hold firmly two tires on their rims. Of these arms, the two lower ones, one of which is clearly seen in the photograph, while the second is largely hidden by the operator's left hand, are fixed; the upper one has considerable travel up and down, being driven by the cam lever which is grasped in the operator's right hand. The cam is clearly seen on the face of the disk, and it will be realized from its shape that at first the arm moves up quite rapidly and easily, but that toward the end of its course it travels much more slowly and can be driven home with considerable force.

The tires are hung on the jaw of this movable arm, and the cam is depressed until the rims come into contact with the fixed jaws of the lower arms. When this occurs the cam lever is well down, and locking is now in order. The holes in the little lug on the cam lever fall over one or another of the holes in the lower part of the disk, along the edge; and a padlock is passed through and snapped, holding the entire device in the tightest position to which the operator's strength is able to jam it. It now becomes clear that, with the very tight bearing that can be got between the face of the jaws and the face of the rim, exact correspondence or extreme tightness between the lips of the jaw and the edges of the rim is not necessary; the tires are held in their place by friction from inside, and not by the grip of the jaws, as such. There is, however, a slight projection in the middle of the jaw which makes it possible to carry a single tire without wabbling, when this is desired.

Planting Trees with Guns

ON the estate of the Duke of Atholl at Dunkeld, Scotland, there is shown to the visitor a rocky crag which, in many places, is quite leafy with the foliage of trees. This crag is called Craigybarns, and some years ago it was destitute of any vegetation. Owing to the steepness of the rock face it was quite impossible for any man to climb to the upper parts, yet it was wished to plant trees in the rock crevices. A proposal was made that the seeds of suitable trees should be shot onto the crag by means of two small muzzle-loading guns. Tin canisters were made of such a size that they would fit into the cannon. These were filled with the seeds of the trees and the covers then put in place. The canisters, with gunpowder, were loaded into the cannon and these were then trained on the crag. When the canisters hit the rock they burst into pieces and the seeds were scattered in all directions. Many of the seeds simply fell to the ground, but a considerable number found their way into the rock crevices. In course of time these seeds grew up into trees, so that now the one-time bare rock is clothed with abundant vegetation.

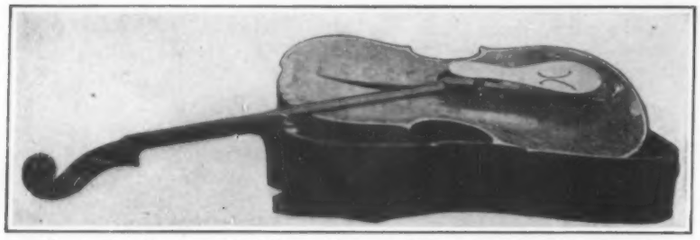
Novel tire carrier that grips the spare rims through cam action

Safety in Handling Gasoline

WHILE the danger from shipping gasoline is often exaggerated, it is true that, in the presence of fire from other causes or of mere sparks that would be harmless under ordinary circumstances, the gasoline barrel or the gasoline tank may be a source of extreme added danger. Among the direct hazards is that of collision on the road between a tank-truck and another vehicle. At such a collision in Kansas City recently, the faucets of the tank received the blow, with the result that 250 gallons of gasoline were sprayed upon the street. Fortunately, nobody dropped a lighted match or a cigarette.

A recently designed safety valve for truck-tanks is aimed at hazards of this sort. The valve is placed between the tank and the faucet; and the plunger-rod carrying the poppet valve of the faucet acts as push-rod for the emergency valve. The ball point of the one works in the socket head of the other. When the faucet is operated the emergency valve opens, and when the faucet is turned off the valve closes. Moreover, if the faucet is broken off or in any other way inoperative the valve closes automatically; the closed position

Safety valve for gasoline feed-lines that checks the flow when the faucet is damaged



Improving the tone of violins with a specially prepared wooden insert

is its natural one and it has to be held open by an open faucet.

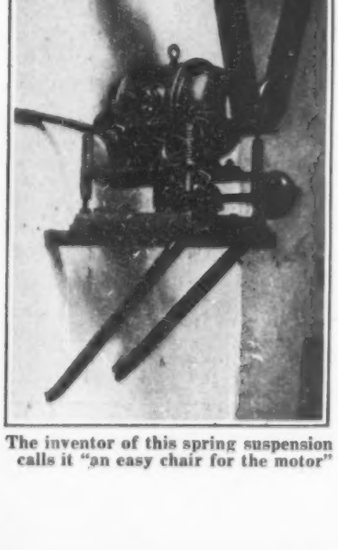
With this valve goes another safety device. The faucet is usually locked open while gasoline is being delivered, and accidents have occurred where the contents of the truck-tank have been ignited through the faucet. But this faucet is locked open by a fusible link of very low melting point; and should fire reach the faucet, the link melts, and both faucet and emergency valve close.

A New Prize Offer

IT may be of interest to our readers to learn that the American Society for the Prevention of Cruelty to Animals, at Madison Avenue and Twenty-sixth Street, New York, N. Y., is offering a cash prize of $10,000 for a device which will render wholly unconscious all cattle, sheep and swine to be slaughtered, before they are jerked into the air or bled. The invention must be one which is operated mechanically, in a manner which is economical, sure, safe and rapid. Further information concerning the contest may be obtained by addressing the society.

Mounting a Motor on Springs

CREDIT for a new principle of motor mounting is claimed on behalf of the German inventor who has planted his motor on its stand through springs, as illustrated. The springs are regulated from above and below by nuts, so that any desired adjustment of tension may be got. It is claimed that with this mounting, the belt drive can be used in many places where it has not heretofore been available; and that the length of the belt may be materially reduced. The vibrations and irregularities of running which would be caused by the endeavor, under ordinary conditions of motor-mounting, to use a belt with such a wide spread as the one illustrated, are said to be completely taken up by the spring suspension, so that the driven shaft runs quietly and smoothly.



The inventor of this spring suspension calls it "an easy chair for the motor"

Tone Producer for String Instruments

A TONE producer designed to improve and increase the tonal quality of all musical string instruments has just been invented. It consists of specially prepared wood so constructed that it conforms with the shape of the instrument in which it is to be used. In recent years, there have been numerous attempts on the part of makers of musical instruments to reproduce the tonal quality found in the creations of the masters. None has been wholly successful, though the nearest approach to that end is claimed by the inventors of the tone producer, which brings the glow of life into the violin, according to the famous violinists who have tried and now use it. The tone producer is inserted under the top of the violin after it has been opened, as shown in the accompanying illustration. The top of the violin is then replaced and the increased volume and sweetness of tone is immediate. The tone producer is scientifically constructed after extensive experiments in matters of acoustics and effects on different woods.

It was found that use of the device in violins in recording laboratories or phonograph record making concerns made it possible to produce a record that brought out to the best advantage the tones of the violin. The tone producer greatly enlarged has been found to give the same tonal qualities to a piano or player-piano.

The Charles A. Coffin Foundation

BY action of its Board of Directors, the General Electric Company has set aside a fund of $400,000 to be known as the "Charles A. Coffin Foundation," the income from which, amounting to approximately $20,000 per year, will be available for encouraging and rewarding service in the electrical field, within and without the company's organization. Prizes will be paid from the fund to the company's employes, recognition will be extended to lighting, power and railroad companies for improvement in service and in technique, and fellowships will be awarded to graduate students, and funds for research work will be established at technical schools and colleges.

The foundation will be controlled and administered by a foundation committee appointed by the board. This committee, within the limits of the purposes for which the foundation is created, will have power to change the conditions applicable to the distribution of the fund and the amounts for each particular purpose.

Each year prizes will be awarded for the most signal contributions by employes of the General Electric Company toward the increase of its efficiency or progress in the electrical art. All employes of the company, except executive officers, heads of departments, works managers, superintendents, district office managers, and similar executives, are eligible for such prizes. In works where employes' representation has been adopted, such representatives will cooperate with the prize committee in awarding prizes in such works.

A gold medal, to be known as the "Charles A. Coffin Medal," will be awarded annually to that public utility operating company within the United States which, during the year, has made the greatest contribution towards increasing the advantages of the use of electric light and power for the convenience and well-being of the public and the benefit of the industry. The company receiving the medal will also receive $1,000 for its Employes' Benefit or similar fund. A similar award will be made in the electric transportation field.

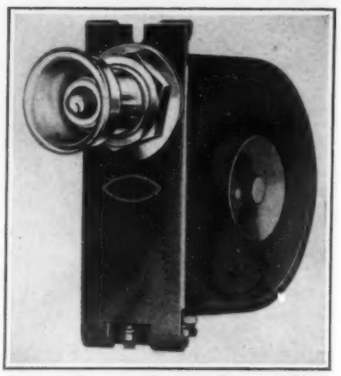
Five thousand dollars is to be awarded annually for fellowships to graduates of American colleges and technical schools, who, by the character of their work, and on the recommendation of the faculty of the institution where they are studied, could with advantage continue their research work either here or abroad; or some portion or all of the fund may be used to further the research work, at any of the colleges or technical schools in the United States. The fields in which these fellowships and funds for research works are to be awarded are electricity, physics and physical chemistry.

A committee appointed by the foundation committee will award such fellowships and funds for research work, with the advice and cooperation of the National Academy of Sciences, the American Institute of Electrical Engineers, and the Society for the Promotion of Engineering Education.

A Cigar-Lighter for the Chauffeur

SOME months ago we took the cigar-lighter as our text in an editorial setting forth the large number of encumbrances which adorn the dashboard of the modern automobile, and the utter dispensability of the majority of these. Our intent in this diatribe was not to attack the cigar-lighter, the clock, or the barometer as such; but merely to suggest that they were being given a consideration to which they were not entitled. There is no particular limit to the comfort or the luxury of modern motoring, and there is no particular sense in decrying this comfort or this luxury. The addition of a fifteenth instrument without doubt gives the car that possesses it a modicum of greater luxury than is enjoyed by the driver with but 14 assorted gadgets at his disposal. But we would rather have the presence of a large variety of non-essentials on the dash regarded as a matter of minor interest—of interest undoubtedly, but not of such paramount importance as to be worth a whole page of ecstasy at current advertising rates.

Nevertheless, we must plead guilty to the soft impeachment put forward by the manufacturer of the cigar-lighter that was indirectly responsible for our little editorial of July last. He said that he would wager the writer of said editorial was not a smoker; and he was right. Perhaps he is right in his feeling

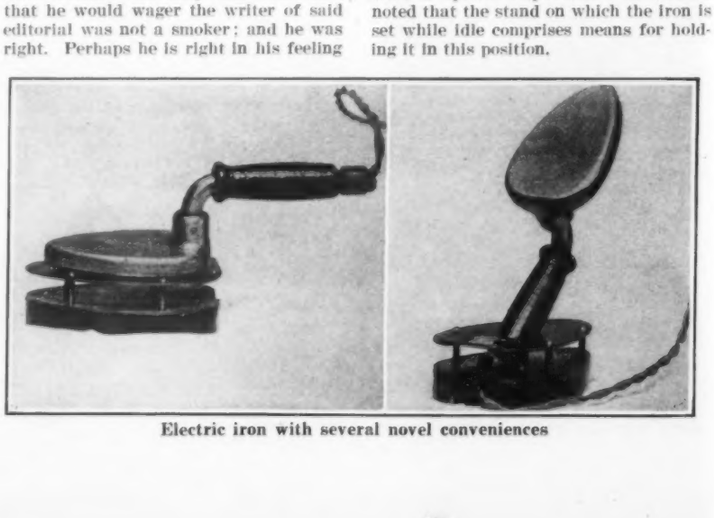


A sure-fire spark may be got from this dashboard cigar-lighter, no matter what the speed of car and wind

that this circumstance necessarily gives a distorted viewpoint. On the other hand, as we have indicated above, we are quite prepared to concede the interest which a smoker would feel in the cigar lighter; and as a measure of that concession, we are picturing the instrument herewith. It will be seen to be admirable in finish, and very handy in use. It pulls out to the extent of several feet of wire, and withdraws into its little hole when released. And it takes no special motion to get a spark out of it; the spark happens automatically by virtue of the wire's being extended to its full travel. Surely one who does want to smoke in the driver's seat could find no handier way of starting the fire than is afforded by this lighter.

A Better Electric Flat-Iron

HOUSEHOLD appliances present to the inventor a field but little narrower than industrial machinery; and a successful invention for the household possesses a far larger potential market than any device addressed solely to the manufacturer ever can. A sample of the extent to which it is possible to improve upon the traditional way of doing things in the domestic establishment is afforded by the electric iron pictured herewith, which is the invention of Albertine Ruelland. In the first place, the sharp edge which makes a crease down the fabric being ironed, is done away with; all the corners and edges of this iron are rounded off. In the bargain, the handle is adjustable, and can be set and secured at any angle whatever to the body, thereby giving much easier attack upon difficult corners of elaborate garments. One trick of considerable utility consists in setting up the iron in a semi-vertical position, as shown in our second photograph, and drawing delicate fabrics over it with the hands. It is possible in this way to iron things that could not otherwise be ironed save with a special implement. It will be noted that the stand on which the iron is set while idle comprises means for holding it in this position.



Electric iron with several novel conveniences

The Service of the Chemist

A Department Devoted to Progress and Achievement in the Field of Applied Chemistry

Conducted by ISMAR GINSBERG, Chemical Engineer

Deterioration of Stored Cement

THE United States Bureau of Mines has been investigating the causes for and the circumstances surrounding the deterioration of cement in storage and in transportation. It was determined conclusively that deterioration of cement stored in bulk is less than in bags, owing to the smaller area exposed. The cement absorbs moisture at its surface only, the interior mass being unaffected. When cement is shipped in bulk a tight closed car must be used, and the cement must be protected from moisture during loading, shipping and unloading. It should be used preferably immediately after unloading. Shipping in bulk possesses the additional advantage of eliminating the use of bags.

Bentonite in Recovery of Newsprint

AN important problem in the paper industry is the conservation of supplies of wood used in the manufacture of newsprint. One method of effecting this conservation is to reuse old newsprint in the manufacture of the paper. This would not offer any great difficulty at all if it were not for the fact that newsprint, printed with carbon black ink, is difficult to free from the fine particles of carbon after the paper has been beaten in the collanders. It is claimed that the mineral bentonite, to which much attention has been given in the recent past, has the property of facilitating the removal of the carbon so that the reworked pulp can be used in the manufacture of paper of suitable color. Old newsprint is first treated with caustic soda and soda ash, which loosens up the carbon black. The real difficulty in the removal of this impurity has been encountered at this point, for it has been found impossible to wash these fine particles out of the pulpy mass without losing a considerable portion of the pulp itself. Finely ground bentonite is added and due to its extreme fineness and large surface area, it passes through any ordinary filter that retains the pulp, carrying with it the fine carbon particles.

New Swedish Alloy

A NEW Swedish alloy, whose name, "Dizigold," seems to indicate that it is a sort of imitation gold, has been introduced on the market. This alloy is made from aluminum and copper, and contains a maximum of 90 per cent of the latter metal. The alloy is claimed to have the lustre and color of gold and can be used in the manufacture of cheap jewelry, and serves as a good substitute for German silver. The alloy is said to possess the hardness and the stability of steel, and resists acids and alkalies perfectly.

Preventing Coal From Igniting Spontaneously

PILES of coal are always subject to the danger of spontaneous ignition, due to the fact that the heat generated within the mass as a result of slow oxidation has not the chance of escaping and of being dissipated. As the heat builds up, the oxidation becomes more rapid and the coal finally bursts into flames. As ships that use coal for the generation of steam, must store large quantities of the fuel in their holds, and as the chance of the heat being dissipated in the enclosed confines of the coal bunkers is much less than when the coal is stored in the open, the danger of spontaneous combustion is accentuated, and to be sure it often happens that the coal does actually catch fire in the hold. An English inventor has devised a plan of preventing this happening by distributing through the coal a substance which is capable of absorbing the oxygen, responsible for the spontaneous combustion. Once this is removed the danger of ignition is past. Such a substance is ordinary iron or iron alloy, whose rusting removes the dangerous oxygen. Some suitable rust-promoting substance is also used in contact with the iron which is in the form of thin sheets. For further details, see British Patent No. 183,109.

Cocaine Antidote

THE *Pharmazeutische Zeitung*, 1922 page 682, recommends the intravenous injection of two cubic centimeters of a 10 per cent solution of chloride of calcium as an antidote in cocaine poisoning.

Making Sulfuric Acid

THE conversion of sulfur dioxide (sulfurous acid) into sulfuric acid is accelerated when salt solutions, for example, iron sulfate solution, are added. The Bureau of Mines has used this phenomenon to accelerate the solution of copper silicate in sulfurous acid. Iron sulfite is oxidized to iron sulfate by air or oxygen. The iron sulfate then reacts with sulfurous acid to form sulfuric acid, which dissolves the copper compound much more readily.

Sour Milk Bread

SOUR milk bread, a Southern delicacy, a product of the negro "mammy," has always been made by the rule-of-thumb method. The negro "mammy" was able to tell by instinct just how much of the sour milk and the soda to add so as to obtain a good product. But the skill of manipulation and the refinement of taste required to do this is fast becoming a lost art, and the ordinary housewife or baker, for that matter, cannot hope to obtain good results on first trial. For there are no two sour milks that are alike and each one requires a certain amount of soda for neutralization, which can only be determined by exact chemical analysis if not by instinct.

However, certain investigations, made at the laboratories of the George Peabody College for Teachers, has rendered it possible for any one, no matter how inexperienced he or she may be, to make these famous Southern biscuits. Just the correct amount of soda must be added; for too much soda makes the bread alkaline in taste and yellow in color, while too little gives it a sour taste and makes it heavy. The use of alizarin paper solves the problem, for when a color change is noted in the paper when a drop of the heated buttermilk is placed thereon, the addition of soda is stopped.

Fungus Stains on Lumber

THERE is a minute plant, which enters the cells of wood, producing a bad stain and doing millions of dollars worth of damage each year. The United States Department of Agriculture is doing considerable work to devise methods of combating this waste. The stains appear in the lumber sometimes as soon as 48 hours after it is cut and begin their penetration into the cells of the wood by means of tiny threads. The plant feeds upon the wood and thus grows in size. These plants have been known to lie dormant in the wood for seven years and then, when conditions become more favorable to their growth, to revive and send out more of the little threads through the wood, staining it yellow, blue, green or red.

New Medication for Toothache

ACCORDING to the *American Journal of Pharmacy*, a bad toothache may be relieved quickly by means of a mixture of equal parts of benzyl alcohol and chloroform. A few drops of the mixture are placed on a piece of absorbent cotton and the saturated material is inserted into the tooth cavity. The action of the medicament is almost instantaneous, and lasts for quite a long time, which is not the case with any other medicament with the exception of cocaine. Benzyl alcohol has been known for a good many years as a very effective local anaesthetic.

Preventing Spontaneous Combustion

IN a recent issue of *Machinery* further proof of the advisability of accurate measurements rather than guesses was presented. In one large plant an electrical thermometer system has been installed in order to detect any increase of temperature in the coal storage pile. The various thermometers are connected with an indicator in the engineer's office. Two hundred and fifty degrees was taken as a safe internal temperature for the pile. Portable receptacles for the thermo-couples were made of one-inch wrought iron pipe, which were welded and pointed, and the exposed end fitted with self-closing cap. The thermo-couples can be placed in the desired receptacles, which are numbered to correspond with the switches in the engineer's office. The system is effective in noting any dangerous increase in temperature in time to take suitable measures.

Vanadium Compounds in Medicine

DUE to the similarity between the properties of the metal vanadium and those of the metals, arsenic, antimony and bismuth, it is not surprising to find that the vanadium compounds are capable of being used for medical purposes. The simple vanadates have been applied in anaemia, tuberculous infections and other chronic diseases with little or no success, but vanadic acid has, however, been recognized as an efficient antiseptic in skin diseases. The use of vanadium compounds of more complex structure in the treatment of syphilitic diseases is also described in the *Journal* of the Society of Chemical Industry, 1922, page 373R.

A New Oleo-Resin, Nauli Gum

THE tree, from which this gum is derived, grows in the Solomon Islands. It is pale yellow in color, fairly soft and has a strong odor of aniseed. The so-called gum contains no gummy constituents at all and yields about 10 per cent of a pale yellow volatile oil, which might be utilized as a source of anethole or as a substitute for anise oil. For further details see *Bulletin*, Imp. Inst., XIX, 4, page 1921.

Zinc Ore Discovered in New Zealand

AN important discovery has been made in New Zealand in the fiord country of Southland. A deposit of franklinite, the zinc ore, which is the same ore that is mined in such large quantities in the State of New Jersey, has been identified by governmental officials. The possibility of using this ore commercially has not yet been worked out.—*Ind. Austr.*, June 8, 1922.

Ammonium Bicarbonate as a Fertilizer

AMMONIUM sulfate manufacture involves the use of sulfuric acid. This adds to the cost of the fertilizer, but does not introduce any new fertilizing value in the product, merely serving to increase the acidity of the soil. Accordingly, it has been suggested in Germany that sulfate of ammonia be replaced by ammonium carbonate, the production of which requires only ammonia, water and carbon dioxide, the latter being only a cheap by-product. It is suggested that the cost of this product will be small in comparison with the sulfate. Certain tests with the new fertilizer, made by the Oldenburg Board of Agriculture, have given favorable results both on sandy and on acid moorland soils.

Glycerine Cement

ACCORDING to the *Allg. Oel und Fett Ztg.*, 1922, number 34, the best glycerine-litharge cement is made in the following manner. A half liter of concentrated glycerine, which does not, however, have to be chemically pure, is mixed with five kilograms of well-dried and finely levigated litharge. The mixture solidifies into a solid mass within 20 to 30 minutes. The cement is so hard that it can be removed only by being chopped out with a chisel. It is resistant to water, acids, mild and even caustic alkalies, chlorine, alcohol vapors and ethereal oils, and it may be used to good advantage on wood, stone, glass, porcelain, metals and other similar materials, as well as in cementing glass to metal. Before the cement is applied, the surface of the materials are smeared with a little viscous crude glycerine.

Alcohol From Acorns

RECENT reports have appeared in the technical press to the effect that alcohol can be made from acorns. Shelled acorns contain about 40 per cent of starch, which can be readily saccharified and then converted into alcohol. The alcohol can then be used as a motor fuel. Up to the present time no industrial use has been made of acorns.

New Uses for Zirconium

THE silicon compound and the carbide of zirconium is recommended as a valuable substitute for the diamond in the cutting of glass. The oxide can be used to good advantage as a substitute for bismuth nitrate or carbonate in X-ray therapy, due to the non-poisonous character of the zirconium salt.—*Mining and Metallurgy.*

Storage Batteries That Are Out of the Ordinary

DUE to the wide use of storage batteries for automobile starting systems and for radio, it is not surprising to find new types of storage batteries being developed at this time.

First of all, we have a new type of storage battery for radio broadcasting purposes which makes use of a solid electrolyte in order to make it non-spillable. This feature will be immediately appreciated by every radio novice who has been unfortunate enough to spill acid on a carpet or on clothes. Another interesting feature is the total absence of the usual separators between the plates. The elimination of the separators reduces the internal resistance to a minimum. In this battery the "grid"—the metal mesh into which is pressed the "active material," forming the "plate"—has a double reinforced construction. This construction adds 25 to 30 per cent more actual metal per square inch, according to the designer. The plate is, consequently, just that much more rugged and does not buckle. This reinforced strength, plus the solid electrolyte, makes the use of separators unnecessary. Due to the fact, however, that the secondary reinforcing mesh in the grid does not come to the surface of the plate, there is actually more active surface per square inch of plate area. In the case of the large storage battery intended for heating the filaments of vacuum tubes, this results in a battery 25 to 30 per cent smaller and, consequently, easier to handle than any other radio battery of equal rating.

The "B" storage battery of this same type, intended for the plate circuit of the usual vacuum tube hookup, is even more unusual and interesting. It is most compact—only four inches square by seven inches long—scarcely larger than a large-sized dry cell "B" battery. It has no glass jars to break, no liquid to leak. The most notable feature is its noiselessness of operation. This last point is an important one, for much of the noises attributed to atmospheric electricity or static can be traced to a leaky or faulty "B" battery.

Then there is another type of novel storage battery, which is shown in the second illustration. The negative plates of this battery are so arranged as to provide orifices into which the cylindrical positive plates are received. There are no separators to impede free circulation in this orifice. All of the exposed area is free for the electrolyte to work upon and produce the chemical changes necessary in a storage battery. At the same time these positive pencils are held securely at the top in the plate, forming the assembly of the grid, in such a manner as to provide a rigid support. The column of lead of which the neck of the pencil is composed is solid at this point, and of sufficient weight to resist the mechanical strain due both to vibration and the chemical action of the cell itself. Held securely in this tapered socket at the top and prevented from engaging in contact with the negative surface by an insulating ring at the bottom, they cannot possibly be short circuited; and yet separators are entirely abolished. This distinct advantage of freedom from separators at once assures to this battery longer life than is possible in any form of battery where separators are used.

In addition, the design of this battery is such that the elements themselves are of greater weight, containing more lead than batteries of the ordinary form, thus contributing to longer life and more rugged qualities.

The fact that the surface area of the new battery allows for unrestricted action of the electrolyte means that this battery possesses rapid recuperative power and ability to stand up under stress and strain sufficient to cause an ordinary battery to fail. These advantages of surface area and circulation allow for more rapid charging of the cell, and consequently a greater ratio of discharge without any resultant harm to the battery.

Another decided advantage is the fact that if several of the charged pencils, which can be readily carried in the tool kit, are carried along, the motorist is at all times supplied with practically a spare battery; for, should there be any failure of the generator to charge, all that would be necessary to do would be to disengage one or two of the discharged pencils in the cell and introduce the charged ones in their place, and the motorist would then have sufficient current for ignition to get home.

Radio-Frequency Amplifiers

SCIENTIFIC Paper No. 449 of the Bureau of Standards describes the construction of a radio-frequency amplifier which uses the transformer coupling method.

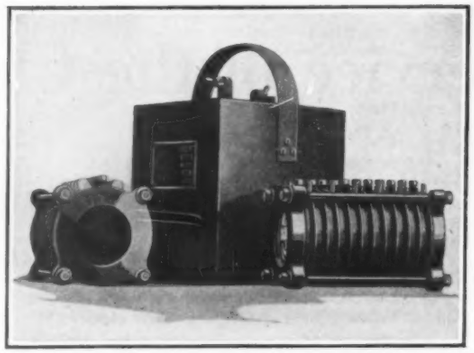
Radio-frequency amplification consists in the amplification of the received radio-frequency current before it is detected. By the use of radio-frequency amplification and a coil antenna, a signal which is very feeble can be made loud enough to be heard throughout a large room.

Three methods are described by which the electron tubes may be coupled together so as to give radio-frequency amplification; resistance coupling, tuned-plate coupling, and transformer coupling, the latter having been found most satisfactory.

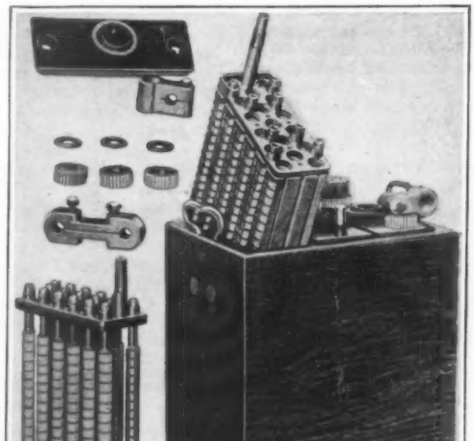
In order to operate well, the radio-frequency amplifier should have a transformer designed so that it will have small capacities in the windings as well as between the windings, and in connecting the transformer in the amplifier circuit care must be taken to have all connecting leads as short as possible.

It has been found that either "air-core" or iron-core transformers may be used for coupling the output of one tube to the input of the next tube. The air-core transformer gives more amplification per stage, but is responsive to only a narrow band of frequencies owing to the low effective resistance of the windings; the iron-core type, while not giving as much per stage, allows amplification over a much broader band of frequencies.

A special type of air-core transformer, which will respond to signals on wave lengths from 600 to 1000 meters, is described. The coils of the transformer were wound in the form of a flat doughnut, the wire being wound in a manner similar to that of the open or basket type of coil winding. They are wound continuously from the inside to the outside. Two of the coils constitute an air-core transformer, one coil being connected in the plate circuit of one tube and the other being connected to the grid circuit of the succeeding tube. It is found that when the primary and secondary transformers are placed about one-half inch apart, the transformer gives best amplification at 600 meters; and when the coils are placed close together, the amplifier operates best at 1000 meters. This is due to the increase of the capacity between the coils when placed adjacent. An amplifier having three stages of radio-frequency, two stages of audio-frequency amplification, and a detector tube may be constructed as described in this paper. The complete paper may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents per copy.



Novel types of "A" and "B" batteries for radio work, which use solid electrolyte and have no separators between the plates



Parts of a storage battery in which the positive plates have the form of renewable pencils, which may be replaced one at a time as replacement becomes necessary

A study in electric lamp relativity: The giant 10-kilowatt and 30-kilowatt lamps and the usual 25-watt electric light

Increasing the Wear Resistance of Sole Leather

THE resistance to wear of sole leather may be increased 25 per cent by a special process which consists of covering the entire surface of the sole with stitches which are looped and locked near the center of the sole. The stitching is done with a wood fiber thread thoroughly saturated with wax and from experiments conducted by the Bureau of Standards in which the wear of specially treated soles of this kind was determined, it would appear that the increase in durability is proportional to the amount of fiber material added to the sole.

Giant Electric Lamps

A 30,000-WATT incandescent lamp, having a capacity of about 60,000 candlepower, the largest lamp of its kind ever manufactured, was shown publicly for the first time at a recent convention of the Illuminating Engineering Society at Swampscott, Mass.

This monster lamp was developed and constructed at the National Lamp Works of the General Electric Company at Cleveland, Ohio, primarily for motion picture studio use. Its wattage is 1200 times larger than the average household lamp, and the electric power required to operate three such lamps would be sufficient to operate the average trolley car.

This lamp has a bulb 12 inches in diameter and 18½ inches high. The light which it produces is equal to the combined light from 2400 electric lamps of the size commonly used in the home. The filament is made of tungsten wire, one-tenth inch in diameter and 93 inches long, constructed in four coils. This wire, if drawn into filament wire of the size used in the 25-watt household lamp, would supply filaments for 55,000 such lamps.

Thirteen of these lamps have been made for a motion picture studio in Schenectady, N. Y., where it is claimed the light from these lamps is equal to or the nearest that has yet come to sunlight. It is claimed the advantage of the incandescent over the arc lamp is the absence of the flicker caused by the carbon filaments and the softer tone of light rays. With the carbon arc lamps, the light is more of a ghastly white and does not bring out the color tones so much desired in motion picture production.

These lights are gas filled. They are lighted from a 120-volt, 250-ampere circuit. Consuming 30 kilowatts, the cost to operate such a lamp, with electric current figured at 10 cents per kilowatt hour, would be $3 per hour.

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGE, M. S. A. E.

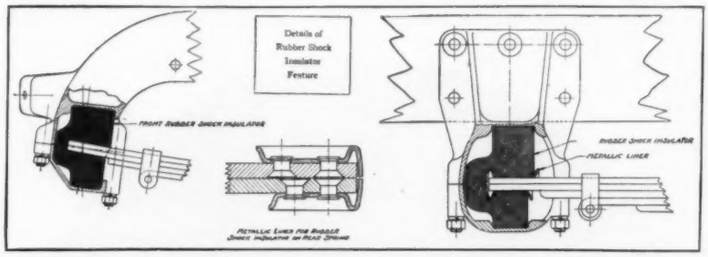
This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Eliminating Spring Shackles

THE chassis improvements of a new motor bus include a new type of spring suspension, the object of which is to eliminate pneumatic tires because of their first cost, their high renewal cost, and the hazard of blowing when the bus is running. The new design of spring suspension permits the use of solid cushion tires without in the least impairing the easy riding qualities of the bus.

The principle of the new spring suspension is that the ends of the springs instead of being attached to the frame by the usual metal spring shackles, are imbedded in rubber blocks held under pressure in housings which are in turn attached to the frame, as illustrated herewith. The rear springs are somewhat differently secured from the front springs as they take the driving thrust forward and backward.

Details of the rear spring suspension are shown. The ends of the two upper leaves are riveted to two metal liners cupped out to fit the rubber block. The shape of the liner is such that there is no slipping of the spring end in the block, but any displacement of the spring—up, down or endwise—is taken up in the rubber block without surface friction or resulting wear. This arrangement allows the use of the Hotchkiss drive as usual. On the front springs no metal liner is necessary as the endwise movement and thrust of the springs are negligible.



Outstanding features of the new scheme for suspending the ends of the springs in rubber blocks, without shackles

Many advantages are claimed for this construction. No lubrication is required. The upkeep is much less, since no grease cups and no grease or oil are required, and no cleansing is necessary. The frame is insulated from many shocks ordinarily transmitted from the springs, thus improving the riding qualities of the vehicle. There is no friction between surfaces, consequently no wear, looseness or rattle. The rubber tends to compensate for twisting action between the spring and the frame. Side and end thrust are taken up without metal-to-metal contact. There is less horizontal motion of axle, because springs elongate from the middle toward both ends. This lessens the steering effort and prevents unnecessary brake action. Crystallization of the frame, steering gear parts and other members, due to vibration transmitted by shackles of the older type, is reduced. The tendency of nuts and rivets to loosen is decreased. The life of the tires is increased. The construction does away with shackles, spring eyes, bushings, hardened and ground steel shackle pins, grease cups, shackle bolts and nuts. Two or more main leaves of the spring can be made to bear in the rubber, thus giving added strength. Spring construction is simplified, since no wrapped eye is required. Cost of assembly and replacement is also less than with spring shackles.

Test runs of 20,000 miles indicate that the rubber blocks will stand up for 25,000 miles without renewal. The eight blocks can be removed by two men in an hour and renewed at a nominal cost.

To show visually the comparative riding qualities of the rubber spring block with cushion tires and the usual spring shackles with pneumatic tires, an instrument is used which records graphically the vibrations transmitted to the frame from the wheels. A needle moves up and down over a traveling record, the extent of the traveling of the needle being determined by the severity of the shock transmitted to the frame. Careful study of an actual record was made while two trucks were traveling on the same stretch of smooth gravel road, one being equipped with the special rubber spring blocks, standard wheels and cushion tires, and the other with the usual spring shackles and pneumatic tires. This record shows that over the same stretches of road the rubber spring blocks not only reduce the severity of the shocks to a marked degree, but also shorten their duration. Briefly the record shows that during these identical runs over the same stretch of road, the rubber spring blocks rode smoother than pneumatic tires. While the object has been to give riding qualities equal to pneumatic tires without the cost of such tires, it was observed that, as a matter of fact, in the vehicle tested, the riding qualities are actually improved by the use of the less expensive tire and the rubber spring block equipment.

Advantages of the Chain Drive

MUCH has been written and a great deal more could be said on the engineering advantages of chain and sprocket drive for motor trucks. Summed up, all of this discussion centers about the incontrovertible fact that the rolling contact of the chain with the sprocket consumes less power and is less affected by different conditions under which it works than other forms of drive. The unsprung weight of a chain-driven truck is less than that of a shaft-driven one, and hence there is less impact on the road and less resultant reaction on the chassis itself. The chain drive is more flexible than a gear drive and the road clearance is better. These are simple propositions, easily comprehended and appreciated.

However, there are practical considerations apart from the mechanical efficiency, weight and road clearance of the chain drive that deserve much emphasis. The ease with which gear-ratio changes can be effected is an advantage enjoyed by the chain-driven truck owner which in certain cases is extremely important. For example, a contractor may find on some hauling jobs that he encounters smooth, hard roads with moderate grades. Common sense dictates a moderate reduction, permitting good speed and economy. The same contractor may take a job of hauling under very different conditions with the same truck, however, in which the roads are soft or hilly or both, where he will need a lower gear-ratio. With a chain-driven truck the change is accomplished by changing the front sprockets and adding or taking out a few chain links. Nothing else is disturbed, the parts affected are entirely accessible and the time required is negligible. With a worm or internal-gear drive, however, the entire driving unit must be taken down, new gears fitted and new adjustments made. It requires many parts and much expensive labor, and is impracticable except for a permanent change.

Reliability is always an asset of the very highest order in any kind of machinery, particularly in connection with transportation. No piece of machinery was ever built that could not and occasionally did not break or fail in some way. The advantage of the chain drive in this particular is that being always visible and accessible, its condition need never be a subject for conjecture. Ample warning is always given of any malady.

When the chains eventually do wear beyond a condition of safety, they give both visible and audible warning of their condition long before a replacement becomes absolutely imperative. Chains which have worn out of pitch, or sprockets which have become hooked, will cause a clicking noise and the chain will be seen to run on and off the sprocket teeth with a jerk instead of smoothly. With this warning the owner may proceed to renew the worn parts at his leisure, as the chain will run without doing any damage whatever for days and even weeks after the condition is first manifested.

With a shaft drive, no such warning is ordinarily given, and the result of wear is nearly always breakage without notice, usually too late to mend the difficulty in time to prevent damage to other parts. In an inclosed drive the only inkling usually given of imminent failure comes after it is too late to remedy the condition in time to effect a cheap repair.

When a part does break or wear out on the chain drive, repair is a matter of a few minutes where it may be days in the case of the gear drive. With the chain drive, on the contrary, the broken or damaged part may be replaced in a few minutes, without jacking up the truck or enlisting outside aid.

In a well known American chain drive a number of exclusive features have been incorporated which raise it out of the class of older types. For one thing, chain reductions are moderate; this permits both front and rear sprockets to be large. The radius rods push directly on the frame instead of on the jack-shaft, thus avoiding shocks on the ends of the jack-shaft which so frequently result in springing the shaft on the other chain drives. Durability is greatly enhanced not only by using liberal sizes of chains, but by having the front sprockets case-hardened.

Bringing commuters to the interurban line from their scattered homes by bus—a demonstration that the bus is not always the enemy of the trolley

Busses as Trolley Feeders

THE fact that he may reside blocks from a car line is not causing the commuter as much inconvenience as formerly. Electric railways in their desire better to serve patrons are installing motor busses for the convenience of riders living in sections not adjacent to car lines, and many a commuter now finds it possible to step from his porch into a waiting motor bus and be whirled away to the nearest transfer point on an electric line. Electric railways are rapidly turning to the motor bus as an economical means for extending service and better serving the public. Numerous well known traction companies have added motor bus equipment in recent months and indications are the electric lines ultimately will become large users of the gasoline carrier.

Railways in a number of cities have purchased busses for the establishing of feeder lines and initial experiments have proved so successful that many roads after giving the bus a thorough trial have decided to increase their bus equipment greatly. The bus offers an excellent cross-town transportation medium and is far less costly than equipment necessary for the operation of electric cars. The Milwaukee Electric Railway and Light Company is a large user of busses. The company has 18 busses as illustrated in service and 9 more on order which will be put on the road within the next few weeks. Three of the company's busses are in interurban service between Milwaukee and Waukesha.

The Heavens in February, 1923

The Debt of Twentieth Century Astronomy to the Nineteenth Century

By Professor Henry Norris Russell, Ph.D.

TIME and again, in these columns, we have told the story of the latest advances made by astronomers of the present day. Fascinating as these are, if we think of nothing else we run grave danger of believing —unconsciously, if not deliberately—that it is to our contemporaries that we owe most of our present knowledge, and of forgetting the equally great men who went before them. It may repay us, therefore, to spend a few moments in reviewing some examples which show how very far wrong such a conclusion would be.

There are branches of astronomy in which the greater part of our present knowledge is half a century old, and recent work has dealt mainly with improvements in the accuracy or the convenience of the older methods, rather than with fundamentally new problems. For example, the observing and cataloging of the positions of the heavenly bodies in the sky is still done with much the same sort of instruments as in the middle of the nineteenth century, and by very similar methods. The precision of the measures has been gradually, though not greatly, improved; but the only conspicuous novelty has been the application of photography. This has revolutionized the measurement of the relative positions of stars which are neither too close together nor too far apart in the sky; but if we want to know how far a star is from the equator, or how far the components of a close double star are from one another, we still use methods that are in principle a century old, because these are still as good as anything that more recent ingenuity has devised.

Putting the Planets in Their Places

When we come to the calculations by which the orbits of planets and comets are worked out from the observations, and the future motions of these bodies are then predicted, we find a similar situation. The main principles of the determination of orbits have been known for a century, and only minor improvements, in the interest of rapidity or precision, remained to be made. The theory of the motions of the planets—including the complex effects of their mutual attraction—achieved its greatest triumph in the discovery of Neptune, 76 years ago. Though various refinements have since been introduced, certain "hard cases" cleared up, and more accurate tables compiled, no great event occurred until Einstein, in our own day, led us to a new and broader way of thinking—and even this change, fundamental as it is in all our physical philosophy, demands no modification of the mathematical or numerical methods by which we solve practical problems. Our predecessors of the last century could do these things as well as we.

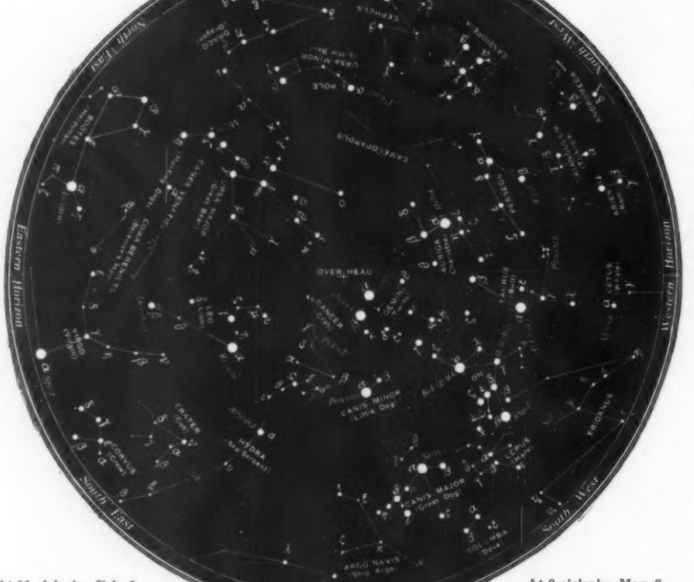
There are other fields, such as the study of the composition, temperature and physical conditions of the heavenly bodies, in which our whole knowledge depends upon the principle of spectroscopy, the laws of radiation, and other advances of physical science that have been made only in the last generation or two. In these matters the earlier astronomers were debarred from competing with us; but nevertheless they showed an extraordinary insight into such problems as they had any chance at all to attack.

The Yard-Stick of the Stars

Take, for example, the measurement or estimation of the distances of the stars. Great advances have been made in this field during the present century—whether in the devising of new methods of attack, in the accuracy and convenience of observation, or in the accumulation of results; and one often thinks of this as distinctly a modern topic. Yet the great astronomers of a century ago had already a sound idea of the probable distances of the stars, and of the ways in which these might be measured.

Newton, who was the first to prove that the stars, since they show no orbital motion around the sun, must be at great distances and must shine by their own light, made a most ingenious calculation of the distance of Sirius, based on the fact that it appeared to the eye to be fainter than Jupiter. He was able to calculate, roughly, what fraction of the whole light of the sun Jupiter caught and reflected, and hence at what distance the sun itself would look as bright as Jupiter does to us. The distance at which the sun would look as bright as Sirius must be still greater, and Newton wisely took this as an indication of the order of magnitude of the distance; thus concluding that even this brightest of the stars was something like 100,000 times as far away as the sun—and, by an obvious inference, that many of the fainter stars might be at more than a million times the sun's distance.

To measure directly the minute parallaxes of such distant objects—their apparent shifts due to the change of the earth from one side of its orbit to the other—was beyond the instrumental power of the seventeenth and eighteenth centuries; but early in the nineteenth, Wilhelm Struve (one of the greatest observers of all history) attacked the problem by measuring, with all possible care, the right ascensions of some twenty-five bright stars in the part of the sky near the north pole. By taking pairs of stars on opposite sides of the pole, such that they crossed the meridian—one above the pole and the other below—within a few minutes of one another, he got rid of almost all the errors of his apparatus; uneven running of his clock, instability of his telescope piers, and so on. He thus secured an accuracy that would have been commendable a century later. His final conclusion was that the average parallax of these stars was only about one-fortieth of a second of arc—which meant that their average distance was over 100 light-years, or some five million times that which separates the earth and the sun; and in the light of our present knowledge we can only say that he was just about right.



At 11 o'clock: Feb. 6
At 10½ o'clock: Feb. 14
At 10 o'clock: Feb. 21

At 9 o'clock: Mar. 7
At 8½ o'clock: Mar. 15
At 8 o'clock: Mar. 22

At 9½ o'clock: March 1

NIGHT SKY: FEBRUARY AND MARCH

Our Nearer Neighbors

This made it evident that only a few of the nearest stars could have parallaxes big enough to measure directly, so Struve set himself to consider how such stars could be picked out. In his discussion of the subject, published in 1837 and written in Latin (then still the international language of learned men) he states clearly the three principal evidences of nearnesses in a star, substantially as we still use them today. The first, and most obvious, is apparent brightness. Other things being equal, the nearer a star is, the brighter it will look. The second is found in large proper motion across the heavens, since here again, the nearer we approach to a star the faster it will seem to move. The third test applies in the case of double stars whose orbits are known. If we assume, as a guess, that the mass of the system is equal to that of the sun, we can get the real distance between the stars by Kepler's laws; and then, from their apparent separation, deduce their distance from us. Struve had very scanty numerical data on which to go; the available estimates of the relative brightness of the sun and the brightest stars were very poor; nothing at all was known of the real velocities of the stars in space, or of their masses. Nevertheless, his final conclusion—that the parallaxes of the nearest stars were somewhere between a quarter and a half second of arc—has again been confirmed by modern observations.

Most remarkable of all, Struve gives a list of 16 stars which, from a combination of these three tests, seem most likely to be near neighbors of ours in space. According to modern measures, every one of these stars is within 50 light-years of the sun; and half of them are within 20 light-years, which compared with the general run of the stars is very near indeed. If we allow for the fact that Struve had no data at his disposal regarding the fainter stars, or those in the far southern sky, his list was almost complete.

Within a year or two after this, the parallaxes of two stars were successfully measured; 61 Cygni by Bessel, and Alpha Centauri by Henderson at the Cape. The first of these stars was prominent on Struve's list; the second would have headed it if he had included southern stars invisible in Europe, for all three of his tests point it out above all others.

The Planets

Mercury is a morning star this month —too near the sun to be seen at first, but coming out later, and best visible about the 22nd, when he is nearly 27° from the sun, and rises about 5.40 A. M. Venus, too, is a morning star, and very bright. She is farthest west of the sun on the 4th —nearly 47°, and looks like a half-moon in the telescope. She is far south of the equator, in Ophiuchus and Sagittarius, and therefore rises rather late, between 4 and 4.15 A. M.; but nevertheless she is exceedingly conspicuous.

Mars is still an evening star, gradually drawing closer to the sun, but also coming northward, so that his hour of setting varies but little, from 9.58 on the 1st to 9.49 on the 28th.

Jupiter is in Libra and comes into quadrature with the sun on the 7th, so that he crosses the meridian at 6 A. M. and is observable in the small hours. Saturn is farther west, in Virgo, about 5° north of the bright star Spica, and rises at 10 P. M. in the middle of the month.

Uranus is now in Aquarius, too near the sun to be seen. Neptune is in Cancer, and comes into opposition on the 6th, at which date he is in 9h. 17m. 17s. R. A. and 15° 59′ 0″ north declination, and is moving 6.6 seconds west and 31″ north per day. There are no convenient stars to help in locating him, and an equatorial telescope will be required to find him.

The moon is full at 11 A. M. on the 1st, in her last quarter at 4 A. M. on the 8th, new at 2 P. M. on the 15th, and in her first quarter at 7 P. M. on the 23rd. She is nearest the earth on the 4th, and remotest on the 20th. During the month she passes near Neptune on the 1st, Saturn on the morning of the 6th (closely, an occulation being visible in tropical America), Jupiter on the 7th, Venus on the 11th, Mercury on the 13th, Uranus on the 16th, Mars on the 20th, and Neptune early on the morning of March 1st.

Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Apparel

ANIMAL HEAD.—M. LICHTENSTEIN, 365 7th Ave., New York, N. Y. The object of the invention is to provide an animal head such as is used on fur scarfs, boas, fur neck-pieces and other fur articles, and arranged to provide a strong and durable mouth clamp to securely clamp the jaws of the animal head on the tail-piece or other portion of the article, and to protect the skin at the under side of the upper jaw against wearing.

TIE CLASP.—H. L. DORFMAN and M. GROSSMAN, 178 Fifth Ave., New York, N. Y. The invention aims to provide a tie clasp which will serve to effectually retain the tie properly applied with respect to the shirt, which clasp will, however, be entirely invisible, so that the tie will present a neat appearance. A further object is to provide a simple device which shall be capable of manufacture at a nominal figure.

Electrical Devices

TESTING DEVICE.—G. E. SMITH, 157 West 78th St., New York, N. Y. The invention relates to testing machines, and pertains more particularly to a device for ascertaining the condition of various electrical appliances. The primary object is to provide a self-contained portable device particularly adapted for testing motor vehicle accessories, such, for example, as vibrator coils, spark plugs, fuses, socket lamps, bells, horns and the like.

ELECTRIC SMOOTHING IRON.—J. G. FISHER, 219 East Capital Street, Washington, D. C. The object of this invention is to provide an electric iron which has organized therewith a quick breaking and non-arching switch and operating mechanism therefor susceptible of being controlled by the person using the iron with the same hand which is utilized for manipulating the iron, without releasing the iron and without the application of a great degree of strength.

BATTERY POST.—E. A. MILLER, 1321 Foster St., Youngstown, Ohio. This invention has for its object to provide a battery post structure in which the vibration to which batteries used in commercial fields, such as in the automobile industry, are subject, will not effect the connection between the post and the battery container so as to cause leakage.

BATTERY BOX.—A. P. TABER, 323 Bush St., Red Wing, Minn. The invention relates to B batteries adapted for use in connection with radio and the like, an object being to provide a construction and arrangement of battery box and cover with devices in the cover for moving the positive and negative terminals of the cells into contact. A further object is to provide a battery in which the cells can be replaced at small cost and by an amateur so that the expense can be reduced to a minimum. (See Fig. 1.)

Of Interest to Farmers

PLANTER.—W. N. DENIKE, 30 Carman Avenue, Winnipeg, Canada. The invention relates more particularly to that class of planters which are manually operated and adapted to be forced into the ground and to provide an opening therein in which the seed, bulb or small plant may be inserted. Another object is to provide a planter with means for planting at a uniform depth, and means for varying and regulating the depth of planting. (See Fig. 2.)

ROAD DRAG.—J. A. GUTRIDGE and J. A. WOOD, McLoud, Okla. The object of the invention is to provide a road drag for grading and rounding up smoothly roadways, wherein a scraper plate is provided having means at its ends for connection with draft animals to travel before and behind the plate, said plate having means for permitting either or both ends to be lifted. A further object is to provide simple means for advancing the device by a tractor.

RESTRAINING APPARATUS.—G. CORTEZ, address E. M. McLaughlin, 2643 Mommouth Ave., Los Angeles, Calif. The invention relates to a restraining apparatus and operating table especially adapted for use in connection with pigs. An object is to provide a restraining or holding apparatus which may be employed for safely holding a pig while being operated upon. The device may be readily ajusted for use in connection with pigs of various sizes, and may be operated entirely by one man, the operator having free access to the animal. (See Fig. 3.)

Of General Interest

PLANT PROTECTOR.—H. C. JONES, deceased, address Mrs. Mary A. Jones, 314 E. Madison St., Pontiac, Ill. An object of the invention is to provide a simple and inexpensive device that is adapted to be placed over a young plant when it has been first transferred to the garden, whereby the plant will be protected from excessive temperature changes, from heavy rain, hail or snow, and from attacks of insects; at the same time the device will permit of proper watering and ventilation and will shade the plant from the direct rays of the mid-day sun.

SECTIONAL METAL SHELVING.—F. J. VINCENT, 501 W. 60th St., Chicago, Ill. Among the objects of the invention is to provide a sectional metal shelving which consists of a plurality of interlocking members, which, when assembled, provide a rigid construction of any number of sections, the sections at the top being as rigid in construction as the sections at the bottom of the device, and the parts being interchangeable.

METHOD OF MAKING HATS.—F. H. DOUB, Whitehouse, Fla. The object of this invention is to provide a method of making hats more capable of withstanding severe usage without impairing their shape. The method consists of producing hats from fiber by grouping two measured quantities with their lengths arranged crosswise to each other, joining the quantities at the point of intersection, working the strands in a substantially circular formation, and maintaining them by a circular series of stitches.

STEEL BARREL.—R. MALLU, 539 Elysian Fields Ave., New Orleans, La. The invention has for its object to provide a sectional or knock-down steel barrel construction by which an assembled barrel can be readily taken apart and the parts nested one within the other for storage or shipment, and may be readily connected so as to produce a barrel which is liquid tight, and provided with the usual bung holes for discharging the contents or dispensing the same in the usual way. (See Fig. 4.)

ANIMATED DOLL.—A. PETROW, P. O. Box 808, San Francisco, Calif. The primary object of the invention is to provide simple and inexpensive means for causing the eyes of the doll to be given a more natural and life-like appearance when the doll is tilted whereby the animation is accentuated. A further object is to provide a means, which will be reliable in operation and easy to install, for producing a lateral and an opening and closing movement of the eyes.

SAFETY RECEPTACLE.—L. B. GROESCHEL, 125 W. 72nd St., New York, N. Y. The invention relates to a protective device in the form of a receptacle in which groceries or the like may be left at a residence in the absence of the owner, without the chance of their being removed by an unscrupulous person. An object is to provide a receptacle which may be left open, and may be locked and attached to some immovable support after the articles have been placed therein.

APPARATUS FOR THE CHANGE OF VIEWS, DESIGNS, OR CHARACTERS.—P. L. BOVIER, 24 Rue de l'Yvette, Paris, France. This invention has for its object an apparatus for the change of views, designs, or characters, automatically operating under the action of vibrations, shocks or jolts, resulting from the running of a vehicle. The apparatus does not comprise any driving spring or mechanism subject to wear or requiring maintenance, not any transmission apt to warp or get out of order; it is characterized by the fact that the driving parts are constituted of small, supple and resilient stems, such as brush bristles or the like.

SMOKING APPLIANCE. — J. W. MILLER, Box 35, Circleville, Ohio. The invention relates particularly to cigar and cigarette holders. An object is to provide a holder which will be capable of radial adjustment to firmly grip the end of a cigar or cigarette. A further object is to provide a holder which will be simple in use, attractive in importance, and provided with clamping mechanism which will not materially increase the cost of the holder.

BOX OPENING DEVICE. — C. S. HUMPHREY, c/o Manhattan Can Company, Bush Terminal Building 10, Brooklyn, N. Y. The invention contemplates a means of attachment for the opening device which eliminates the necessity of perforating or otherwise forming the cover with an aperture. Furthermore the means of attachment which consists in forming a plait or fold in the cover which receives one extremity of the opening device, provides the cover with an annular bead with which the fingers may coact for more readily effecting the removal of the cover.

FOOD PRODUCT.—MARIE BLOCH, 147 Cebra Ave., Stapleton, S. I., N. Y. It is an object of the invention to produce a food product which in a manner takes the place of macaroni, noodles or other similar food, which is healthful and nutritious, and which may be manufactured and sold in packages or bulk and then cooked by the consumer. The product consists of about six ounces of concentrated tomatoes, one ounce of egg, and fourteen ounces of flour.

ADVERTISING DEVICE.—A. F. FORMAN, c/o Forman Film Company, 415 North Chicago Ave., South Milwaukee, Wis. Among the objects of this invention is to provide an advertising device embodying a wheel adapted to carry on the periphery thereof, a plurality of pictures or advertisements and having a mechanism for driving the wheel intermittently, and also having means for projecting images of the several views on a distant screen or the like.

RAZOR STROP—H. E. REX, General Delivery, Oroville, Calif. The invention refers more particularly to a combination strop and razor holder, so arranged that the strop may be folded upon itself to form a pocket for holding a straight razor, and with the folds clamped in such position by the handle of the strop that a shaving brush may also be conveniently carried at the closed end of the folds, thus making a convenient package of a razor with the strop and brush.

MOP HOLDER.—E. J. ZITZMAN, 601 West 176th St., New York, N. Y. This invention has for its object to provide a construction wherein the mop body may be easily removed or applied. Another object is to provide a mop head in which a sliding or pivoted clamping arm is used for holding the mop body to the head, together with guiding members for guiding the clamping bar as it is moved.

SIGN.—J. P. FOX, c/o Fox Auto Sign Company, St. Cloud, Minn. The object of the invention is to provide an artistic and attractive sign which may be easily positioned in a conspicuous manner at a retail gasolene station, or the like, and which is adapted to carry numerals, of sufficient size to be easily read, for indicating the retail price of gasolene, or other commodities.

MEANS FOR ELIMINATING ERRORS IN BOOKKEEPING AND THE LIKE.—W. J. B. DE HOOG, 96 Van Beek St., Doornfontein, Johannesburg, Transvaal, South Africa. According to this invention a device is provided by means of which various entries in various books, folios and the like can be assembled in such a manner as to permit of being readily dealt with. The essential details of the invention consist of a frame and a carrier capable of relative movement and means for mounting paper on the carrier for giving it a movement in a direction transverse to said relative movement when required.

BUILDING WALL.—T. J. BRUMBACK, 488 North Pacific St., Cape Girardeau, Mo. The purpose of the invention is to provide a building wall composed of a plurality of building units each of which is provided with tongues and grooves designed to receive the plaster material and to thus firmly secure the material to the units and the units to each other. A further object is to provide building units in conjunction with a concrete wall arranged between the two to provide a dead air space for preventing the transmission of moisture.

HOLDER FOR STROPPING SAFETY-RAZOR BLADES.—A. F. ISCHINGER, 1 Woodlawn Ave., Mt. Oliver Station, Pittsburgh, Pa. The object of the invention is

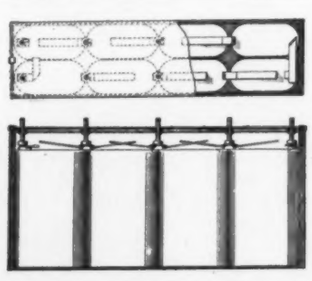


Fig. 1: Box for radio B-batteries, etc., invented by A. P. Taber

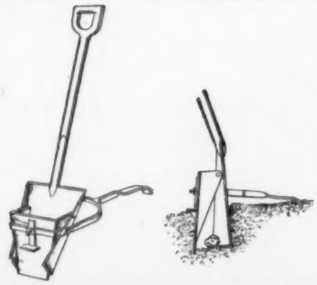


Fig. 2: Improved planting tool patented by W. N. Denike

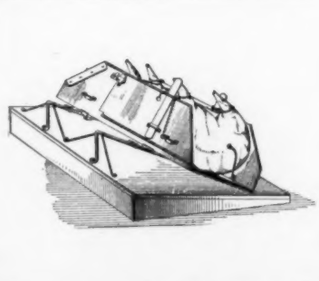


Fig. 3: G. Cortez' device for restraining pigs during inoculation or other surgical operation

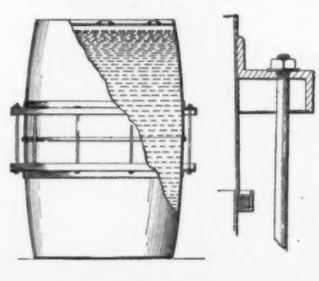


Fig. 4: Sectional knock-down steel barrel designed by R. Mallu

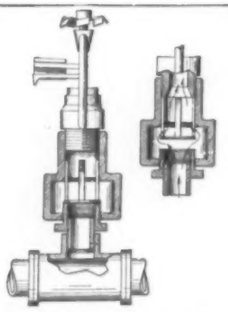


Fig. 5: Automatic sprinkler-head check-valve patented by A. S. Curney

Fig. 6: W. C. Hollowell's novel device for rendering lard

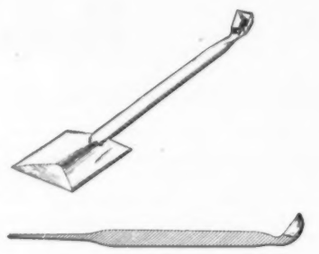


Fig. 7: Improved scraper for pots and pans, invented by E. M. Hibbler

to provide a simple inexpensive and efficient holder so constructed that the safety-razor blade can be securely held within the holder during stropping or honing of the blade, and can be readily detached from the holder.

DRY MOP HOLDER.—C. Hauk, Jr., 1966 University Ave., New York, N. Y. One of the primary objects of the invention is to provide a receptacle adapted to contain dry mops when the latter are not in use, and in which the mops may be cleaned, closure means being drawn tightly around the mop handle during the cleaning operation. A further object is to provide means upon the interior of the receptacle against which the mop is adapted to be beaten to dislodge the dust.

DIVIDER AND REINFORCING STRIP.—S. H. Calkins, 126 Franklin St., Long Island City, N. Y. The invention relates to strips for concrete work, particularly for Serrazzo coatings and has for an object to provide a construction wherein the strip may be bent to the desired shape easily and then anchored correctly. Another object is to provide a strip which will act as a dividing member for dividing concrete work into sections and at the same time act as a reinforcement for the section or blocks.

FOOD CHOPPER.—I. M. Lentuch, 339 Bradford St., Brooklyn, N. Y. The invention contemplates a food chopper embodying a hopper having an inlet and an outlet within which the food is held stationary, and a grating, shredding, slicing or other cutting element acting upon vegetables, fruits, cheese, or other foods of this character. A further object is to provide a simple and inexpensive food chopper with which a plurality of interchangeable cutting elements may be associated and the parts easily cleaned.

AUTOMATIC SPRINKLER HEAD CHECK.—A. S. Curney, 2240 Lincoln Ave., Chicago, Ill. This invention relates more particularly to a valve which is used in connection with an ordinary fire sprinkler head. The principal object is to provide a simple and positive means for shutting off the water at the sprinkler head instead of at the source of supply, thus stopping the flow of water and permitting the replacement of a new head or the resetting of the old one. (See Fig. 5.)

HANGER.—J. R. Helden, 1905 First Ave., N., Birmingham, Ala. This invention relates to hangers especially adapted for supporting articles in elevated position. An important object is to provide a hanger having means for supporting articles in elevated positions and having means whereby the holding means may be released when desired to permit the article to be lowered.

DISPLAY DOLL AND DRESS OUTFIT.—G. Baum, 573 Westminster Road, Brooklyn, N. Y. The invention is especially intended for the display of a child's dress. The object is attained by providing an outfit in which a miniature dressed figure is held in the container in juxtaposition to the folded dress, the doll's dress corresponding in every respect with the child's dress, the one serving to satisfy the inquirer as to the general appearance of the dress as worn.

DEVICE FOR RENDERING LARD.—W. C. Hollowell, R. F. D. No. 1, Kenly, N. C. The object of this invention is to provide a device of the above character which is adapted to be placed over a receptacle into which it is intended to store the lard being rendered. The device is so constructed that it is easy to manipulate for rendering lard in a highly efficient and expeditious manner. (See Fig. 6.)

BASE.—W. H. Francis, c/o E. R. Dick, Coffeyville, Kans. The invention aims to provide a construction more particularly adapted for use in association with the method and apparatus for handling and stacking bricks. The base includes side members and end pieces between the side members, one of said end pieces being adapted to receive the bricks, said side pieces being capable of receiving a carrier or vehicle, and to prevent the same from slipping when the bricks are being stacked.

CAMP OVEN.—E. B. Prettyman, c/o Porterville Hardware Co., Porterville, Calif. The invention relates particularly to a stove which is easy to transport, efficient in its use by allowing two fires to heat it simultaneously, and that will at the same time prevent the contents of the stove from getting burnt. This stove need not be partly buried in the ground, and may be used for baking anything that can be baked in the ordinary kitchen stove.

LADY'S POCKETBOOK.—B. Stember, 36 East 22nd St., New York, N. Y. The object of the invention is to provide a lady's pocketbook arranged to furnish an extra commodious compartment for convenient storage of handkerchiefs and other more or less bulky articles. Another object is to maintain the general appearance of a pocketbook in contra-distinction to a hand bag, and to provide a pocketbook which will be strong, durable and close folding.

SCRAPER FOR POTS AND PANS.—E. M. Hibbler, Clarksdale, Miss. The invention relates more particularly to an implement for use in cleaning pots and pans, the object being the provision of an implement having at one end an approximately flat blade with three sharpened edges and having at the opposite end a cup-like scraping member provided with three cutting or scraping edges, for effective use in the cleaning of pots and pans. (See Fig. 7.)

DEPRESSIBLE PLATFORM.—H. R. Simpson, 1005 Mission St., San Francisco, Cal. Among the objects of the invention is to provide a depressible platform for various purposes, and especially in connection with bank vaults, the particular advantage being that this platform can be handled without much force and that it has spring means which automatically assist in the platform, while this spring means is rendered inactive when the platform is in its lowermost position.

FILTER.—M. A. Menke, 614 Third St., N. W., Washington, D. C. An object of this invention is to provide means for holding the filter paper away from the surface of the funnel so as to enlarge or extend the filtering area of the paper and prevent the sticking of the paper to the walls of the funnel. A further object is to provide a longitudinally corrugated wire member for supporting and spacing the filter paper from the inner walls of the funnel.

QUOIN.—M. O. Cooper, 2385 Van Cortlandt Ave., Brooklyn, N. Y. The invention relates to printer's quoins, the principal object being to provide a device comprising the usual pair of coacting members so constructed that the wedge members are positively held against accidental slipping or relative movement in any direction, so that there is no danger of losing one part of the quoin and no necessity for matching up the various wedge members when it becomes necessary to use a quoin.

OUTSIDE WINDOW SHADE.—E. Flagg, 111 East 40th St., New York, N. Y. This invention is designed to overcome the difficulties of hanging a window shade at the outside of the window. The patentee provides an arrangement to guide the controlling cord by carrying the cord upwardly at the outside into the frame head through a sinking at the under side, and provides guide eyes for leading the cord inwardly.

JEWELRY SETTING.—R. Greenfield, 135 Canal St., New York, N. Y. This invention has for its object the provision of means whereby a jewel may be fastened in place on the setting and released therefrom in a very simple manner. Another object resides in the provision of means whereby the support for the jewel is readily adjustable and yet is as secure and firm as the usual type of setting.

PATTERN AND METHOD OF MAKING SAME.—A. A. Meyer, 18 West 38th St., New York, N. Y. The invention has for an object the provision of a simple pattern and method of making the same whereby a person preparing a pattern and draping a model with a garment to be made of such material as fur can readily and much more effectively visualize the harmony and arrangement of the various parts of the garment as the pattern prepared in accordance with this method is draped on the model.

ADVERTISING DEVICE.—J. L. Celane and D. Steinberg, 147 Essex St., New York, N. Y. The primary object of the invention is to provide revolving means moving in the presence of illuminating means to cast shadows of various images upon a reflecting surface in such a manner that the images will move relatively to the reflecting surface. A further object is to so construct the device that the revolving member is operated by the heat thrown off from the illuminating means.

NOSE PIECE FOR EYEGLASSES.—F. G. Procter, Jr., Portsmouth, N. H. Among the objects is to provide a nose-piece construction in which a bridge of greater strength may be had. A further object is to provide means whereby the springs of the mounting may be protected against injury, and at the same time provide for adjustment of the spring without removal of the guard arm.

SWING.—A. F. Eycleshymer, 101 South 12th St., Niles, Mich. An object of the invention is to provide a child's swing of simplified construction which can be propelled readily by a child to swing. A further object is to provide a swing which can be readily attached to various fixed supports, as for instance a ceiling wall, and which includes no parts which are likely to occasion injury to the child during the operation of the swing, and having means for holding the swing against movement laterally of the direction of its oscillation.

REFRIGERATOR.—C. D. Behan and G. G. Perry, c/o Chas. D. Behan, Stigler, Okla. This invention relates to a refrigerator or cooling system therefor adapted to make use of the water of condensation and water of the melting ice, so as to refrigerate the interior of the chamber by the circulated water, in addition to the cooling action of the ice, thus economizing, while maintaining the interior of the refrigerator, and especially the provision chamber at a low temperature.

METHOD OF HANDLING ARTICLES AND APPARATUS THEREFOR.—W. H. Francis, c/o E. R. Dide, Coffeyville Vitrified Brick and Tile Co., Cherryville, Kan. The invention is primarily intended for use in connection with the handling of bricks, but may be readily utilized in handling blocks and articles of any character, in such a manner that no injury to the same will result, as long as these articles lend themselves to a stacking process, and by means of which a man of ordinary strength may be capable of handling, with facility a large number of objects.

HOISTING HOOK.—W. C. Carey, U. S. Q. 16, Deer Park, La. Among the objects of this invention is to provide a releasing hoisting hook especially adapted for subaqueous river and harbor work, and more particularly to a hook of the releasing type especially adapted for the placing of mattresses and the like in revetment work. Another object is the provision of a hoisting hook in which the releasing operation is automatically carried out, the hook stripping itself in its releasing movement.

BROOM HOLDER.—E. Hartman, Sr., 171 South Morris Street, Dover, N. J. The invention has for its object to provide a holder adapted to be applied to a wall or the like and to yieldingly receive the handle of a broom suspended. The general object is to provide in connection with the holder a handle displacing device against which the handle may be moved to assist in the ready disengagement of the handle from the holder.

WRITING AND STUDYING CHAIR.—H. R. Wilkins, Greenville, S. C. The object of the invention is to provide a chair provided with receptacles for receiving books and writing implements, and particularly adapted for school children. An important object is the provision of a shelf supported by the arm of the chair and adapted to be swung in position for serving as a table for writing and also adapted to be swung into position where it will not interfere with the using of the chair for ordinary purposes.

CLASP.—W. Fischer, 67 Cortlandt Street, New York, N. Y. The invention is intended more particularly for embodiment in a clasp for a necklace. An object is to provide a clasp assemblage in which the click will have increased resiliency to effectively hold it in engagement with the cross bar, and to effectively apply the spring pressure in holding the click in engagement on the body.

CARBOY CARRIER.—A. J. Becker, Box 275, Caldwell, N. J. The primary object of the invention is to provide a carrier which may be used by one man to conveniently transport carboys, and a carrier which will tightly grip carboys of various sizes so that there is no danger of breakage and consequent injury to the carrying workman from the burning acid usually contained in carboys.

CLASP.—L. Jarner, c/o Myers Company, 717 Market Street, San Francisco, Cal. The invention relates to separable fastenings for detachably coupling the ends of necklaces, bracelets or similar articles of jewelry. One of the principal objects is to provide a clasp which insures a positive locking of the interengageable elements. A further object aims to provide a simple clasp with means to facilitate ready engagement or disengagement of the same.

Hardware and Tools

BRACE.—F. M. Brown, Box 503, Wilson, Okla. Among the objects of the invention is to provide a brace having a chuck of greater capacity in a given size than is usual. A further object is to provide a chuck having adjustable gripping members adapted to effectively hold tools of various sizes. The device is easy of adjustment, simple in construction, and not thoroughly practical commercially.

TORCH.—E. Folgman, 33 St. Mark's Place, Brooklyn, N. Y. The invention relates to self-blowing torches. The primary object is to provide means for relieving the pressure in the main fuel reservoir without causing a discharge of fuel from the wick in the wick tube. A further object is to so construct this discharge element that it is

bodily removable from the wick tube for the purpose of cleaning.

PERMUTATION PADLOCK.—D. W. ROHRER, 230 South Cook Ave., Trenton, N. J. An object of the invention is to provide a permutation padlock in which the use of a multiplicity of tumblers is dispensed with. A further object is to provide means for changing the combination, and to so construct the padlock that the locking means is positively actuated to release the shackle.

NUT LOCK.—S. C. ENZENAUER, Bancroft, Idaho. The object of the invention is the provision of a nut lock comprising a nut carried locking key adapted to cooperate with a grooved or channeled bolt to effect the locking of the nut against rotation on the bolt, the key being mounted upon the nut in such manner as to be yieldingly and releasably held in locking position and to thus be capable of movement to released position to allow of the rotation or removal of the nut.

CORNER FASTENING FOR BEDSTEADS.—W. A. KOCH, c/o Evansville Metal Bed Company, Evansville, Ind. This invention refers more particularly to corner fastenings for metal beds using the ordinary angle side rails whereby the side rails may be reversed and adapted to support either the ordinary box spring bottoms or slats. An object is to provide a metal fastening that shall be simple in construction, positive in action, and which may be used with any form of bed post, either metal or wood.

ANGLE-CUTTING GUIDE FOR LATHES.—G. A. MAGNUSON, c/o Carl A. Magnuson, Tiskilwa, Ill. Among the objects of this invention is to provide a simple device which may be attached to a lathe, and by means of which bevel gears, bevel rolls, etc., may be readily and accurately cut by means of an ordinary round nosed tool. A further object is to provide a device which may be readily attached to lathes of existing type, or readily removed therefrom.

HAND TOOL FOR FASTENING STEEL PAIL TOPS.—S. M. JOHNSON, Middlefield, Ohio. An object of the invention is to provide a simple hand tool by means of which the lugs of a pail cover can be crimped under one by one and the cover drawn down tight. The tool consists of a piece of heavy spring steel doubled upon itself to form a handle, one end forming a crimping jaw for engaging a lug, the other end for engaging and drawing the flange of the cover down.

LOCK.—C. A. PRESCOTT, 49 San Juan Avenue, Victoria, B. C., Canada. An object of this invention is to provide a simple lock with a spring held latch operable upon the turning of the shank. The lock is so constructed that it is easy to install, durable and efficient in use, and is unlikely to get out of order.

WIRE TWISTER.—S. M. JOHNSON, Middlefield, Ohio. This invention has for its object to provide a simple device for twisting the wires which hold the tops of candy pails in place. A further object is to provide a simple portable hand-operated tool, which has simply to be set on the wires of the pail and given a few turns in order to twist the wires and hold the top in place.

Heating and Lighting

CONTROLLING DEVICE FOR GAS JETS.—J. S. KRAKER, 354 Hunter St., Ossining, N. Y. The invention relates to controlling devices for burners connected with gas jets or gas stoves. The principal object is to provide means for cutting off the flow of fuel to a burner upon the accidental extinction of the flame. Another object is to provide a magnetically operative means for accomplishing the purpose in view, which is purely automatic in its operation, and is in the nature of an attachment applicable to any standard fixture.

DRAFT REGULATOR FOR FURNACES.—C. R. MCCOLLUM, Gladston, N. J. An object of the invention is to provide a construction wherein the controlling drafts of a furnace and of a smoke pipe may be set to any desired position from a distant point. Another object is to provide a comparatively small apparatus, electrically operated for opening and closing the drafts, and controllable from one or more points in a house.

ARCH BRICK.—J. H. DEMPSEY, 4815 Franklin Avenue, Cleveland, Ohio. The invention relates to a refractory brick or tile which is supported upon the arch tubes of a boiler fire-box, to form an arch, to control or direct the flow of smoke and gases through the boiler. A further object is to provide a construction of brick which, when assembled on the arch tubes, present a smooth surface to the fire-box side.

HEATING STOVE.—H. W. SIEVER, 519 Trendley Avenue, East St. Louis, Ill. Among the objects of the invention is to provide a stove of simple construction, with means for conducting air to the combustion chamber to mingle with the combustible gases therein, whereby practically all the combustible elements in a fuel charge are utilized in the generation of heat. A further object is to provide means for deflecting the ascending heat current radially.

OIL BURNER.—J. A. WILLIAMS, 1940 East 14th Street, Oakland, Cal. The primary object is to provide an oil burner which is simple in construction, inexpensive to manufacture, yet embodying certain mechanical principles which enable it to carry out its intended use with the greatest efficiency, and accomplish results which have heretofore been absent in devices of this character.

Machines and Mechanical Devices

DOOR OPENING APPARATUS.—J. E. W. FOGAL and C. L. FULGHUM, Quincy Elevator Gate Co., Quincy, Ill. The invention relates to an electrically operated door control means to doors for buildings. A purpose is to provide a control means which has a plurality of remote switches or buttons placed at different points of convenience throughout a building in order to open and close the doors of said building. The device is capable of handling all types of doors, such as folding, sliding, or lifting doors.

ROTARY MACHINE FOR PRODUCING POSITIVE COPIES OF NEGATIVE CINEMA FILMS.—A. DEBRAYER, Paris, France. The invention relates to a machine for producing a better contact between the negative and positive films. The characteristic feature of the device consists in causing the negative and positive films to describe an arc of a circle, as, by so doing, a perfect contact is obtained between the two films.

GAS ENERGY CONTROL FOR FLOWING OIL OR GAS WELLS.—E. V. CROWELL, 826 Santa Fe Ave., Los Angeles, Calif. The invention relates to a gas energy control for flowing oil or gas wells, and is adapted to utilize in a most efficient manner the gas contained in or present with the oil. An important object is to provide a device which may be installed to provide a proper flow of oil by gradually lowering the device as the gas energy declines with the age of the well.

STRIPPING MACHINE.—C. M. MOGNI, 325 West Fourth St., New York, N. Y. The invention aims to provide a stripping machine which will be capable of producing such articles as brushes of any type, having their bristle elements virtually incapable of becoming accidentally removed. A further object is the construction of a machine, as well as the article of manufacture produced thereby, which machine will be practically automatic in operation, and extremely simple in construction.

REVERSIBLE-SLIP SUCKER ROD SOCKET.—A. H. NIELSON, 1631 East First St., Tulsa, Okla. Among the objects of the invention is to produce a socket rod comprising a barrel with a tapered bore and a slip-body tapered in opposite directions for reversible insertion in said bore, the two-diameter toothed bores of the slip-body being arranged on slight tapers, the means which hold the slips from dropping apart being loose enough to enable a wider separation at the top than at the bottom.

GRINDING MILL.—J. B. SEDBERRY, c/o The Bossert Corp., Utica, N. Y. This invention relates to mills for grinding and pulverizing material of any character, and the purpose is to provide a mill having stationary and movable grinding elements which coact to effect a thorough grinding of grain. It is also a purpose to provide grinding elements which are interchangeable, and reversible to present new grinding surfaces when the other surfaces become dulled.

TRIMMING MACHINE ATTACHMENT.—M. POETZSCH, 91 Overbrook Road, Ridgewood, N. J. An object is to provide an apparatus for cutting certain parts of fabric in order to reduce the thickness thereof and thereby produce a design or configuration. Parts of the machine may be adjusted to cause the cutter to shear the nap at a certain level continuously, or be caused to shear the nap at different depths and thereby produce different designs.

INK-LINE-MAKING ATTACHMENT FOR TYPEWRITING MACHINES.—R. GUERRERO, P. 206 Salvador Donoso St., Valparaiso, Chile. The invention relates to an ink-drawing device comprising a tubular member carrying a tracer wheel, means for turning the axis of said wheel in different positions at approximately right angles, and means for displacing said tubular member in a plane transverse to its axis.

VENDING MACHINE.—A. ZIEGLER, 916 Norton St., Scranton, Pa. The object of the invention is to provide a coin-operated vending machine, more particularly adapted for the dispensing of fluids, such as gasoline and oil, although the device may be employed in connection with dispensing any substance, and will operate properly under any number of combinations of coins, as long as the total of the same reaches the required amount. A further object is to provide for the return of the coins provided the machine fails to operate.

AUTOMATIC PRINTING AND RECORDING MECHANISM FOR SCALES.—H. NOBLE, 122 Pembroke St., Boston, Mass. The invention contemplates the provision of a mechanism for automatically printing on a card or strip the correct weight of the article weighed by the scale, and to cause the same to coincide with the weight indicated by the dial of the scale. Another object resides in the provision of means for throwing the actuating mechanism out of operation when the printing mechanism has been operated.

TRANSMISSION MECHANISM.—E. E. COOK, c/o Precision Engine Works, 838 North Wells St., Chicago, Ill. An object of the invention is to provide a transmission mechanism of the friction type in which the speed of the driven wheel may be varied from a maximum forward speed to the reverse through all intermediate speeds, and in which means is provided for throwing the intermediate friction disk out of engagement with the friction drive wheel and the friction driven wheel and for transmitting the driving force directly from the drive wheel to the driven wheel through direct clutch engagement.

MEANS FOR SHAPING AND TEMPERING LEAF SPRINGS.—A. V. DOUGLAS, 710 Court St., Pueblo, Col. Among the objects of the invention is to provide a simple, inexpensive and effective means for shaping leaves of leaf-springs as desired and for maintaining the leaves in adjusted relative positions while immersed in a tempering fluid. The device may be adjusted for use in shaping leaves of various sizes.

FRAMING DEVICE.—E. S. PORTER, c/o Precision Machine Company, 317 East 34th St., New York, N. Y. The invention relates to moving picture machines. An object is to provide a framing device which is in the nature of a gage registering with the film at a point removed from the aperture of the projecting machine so as to permit a proper framing of the picture without the necessity of looking through the aperture, and without danger to the operator. The device may be readily attached to projecting machines in common use.

SCALE.—G. G. and E. L. VOLAND, 48 Trinity Place, New Rochelle, N. Y. The invention pertains more particularly to scales of the more sensitive type where adjustments are very minute. Usually two mechanisms are provided, one for engaging the scale beam and lifting it, the other engaging the scale bows and pans. The primary object of the invention is to so construct such mechanism that the support for the scale beam and the support for the bows and pans are operated simultaneously.

STRING-BEAN CUTTING MACHINE.—F. C. LEWIS, c/o Ethical Culture School, Central Park West and 63rd St., New York, N. Y. The general object is to provide a machine which is adapted to cut string beans into sections of a desirable length in a highly efficient manner. The machine is adapted to deposit the ends or tips of the beans in a separate receptacle from that in which the bodies of the cut beans are deposited.

CANDY-CUTTING MACHINE.—H. RICCI, 244 Clement St., San Francisco, Calif. The particular object of this invention is to provide a machine which is adapted to cut a slab of candy into longitudinal slices of a desired width and is provided with a plurality of sets of cutting blades which may be selectively used to secure slices of different widths. A further object is to secure a clean cut and to prevent the adhering of the candy to the blades.

CALENDER RACK.—J. STANLEY and W. H. CARSON, West Point, Ga. This invention relates to calender racks especially adapted for use on picking machines employed in textile mills. An important object is to provide automatic means whereby the calender rack is rendered inoperative when the load or strain on the same exceeds a predetermined point. The rack is secured in such a way that in the event of a break it may be replaced in a short time.

ATTACHMENT FOR SEWING MACHINES.—L. LIEBMAN, 40 E. 12th St., New York, N. Y. This invention is particularly designed for the purpose of manufacturing waistband linings for trousers. The invention contemplates an attachment for use in connection with a sewing machine which comprises a means for folding the covering strip and assembling therewith the stiffening strip for presenting the same in assembled relation to the sewing machine mechanism for stitching the same together.

METAL BENDING MACHINE.—D. T. FREDERICKSON and E. L. FAULKNER, Box 487, Guthrie, Okla. The object of the invention is to provide a metal bending machine which is especially adapted for bending reinforcement rods used in concrete structures, which possesses a high degree of universality in that it is adaptable to work upon various size rods or bars to form them to any desired shape, which is of simple and durable construction, and does not require a skilled operator.

BORING MACHINE.—J. H. HAMLIN, Box 572, Winston-Salem, N. C. An important object of the invention is to provide a boring tool for sectional bearings having attaching means which properly position the cutting devices so that as they are passed through the work, the same will provide the inner face of the bearing with a smooth surface. A further object is to provide a boring machine which may be used on an internal combustion engine for cutting the bearings without dismantling the engine.

CUTTING MACHINE.—V. GUARDINO, 3014 Ocean Avenue Sheepshead Bay, Brooklyn, N. Y. The invention aims to provide a device more particularly adapted for use in connection with the cutting of blocks of frozen cream into slices. A further object is to provide a device by means of which the handling of the frozen blocks of cream will be minimized and a great number of equal sized blocks cuts within a given period.

SEALING MACHINE.—F. E. RICKARD and D. R. ROBINSON, c/o Faydon Sealing Machine Company, 732 Federal Street, Chicago, Ill. An object of the invention is to provide a machine by means of which pamphlets, circulars and similar articles may be accurately sealed. A further object is to provide a machine in which the seals are taken one by one from a receptacle, moistened and applied to the edge of the pamphlet, then bent over and pressed securely, means being also provided for preventing the delivery of a seal in case there should be no pamphlet ready to receive it, and automatic means for positioning the articles so that each article is sealed in substantially the same place.

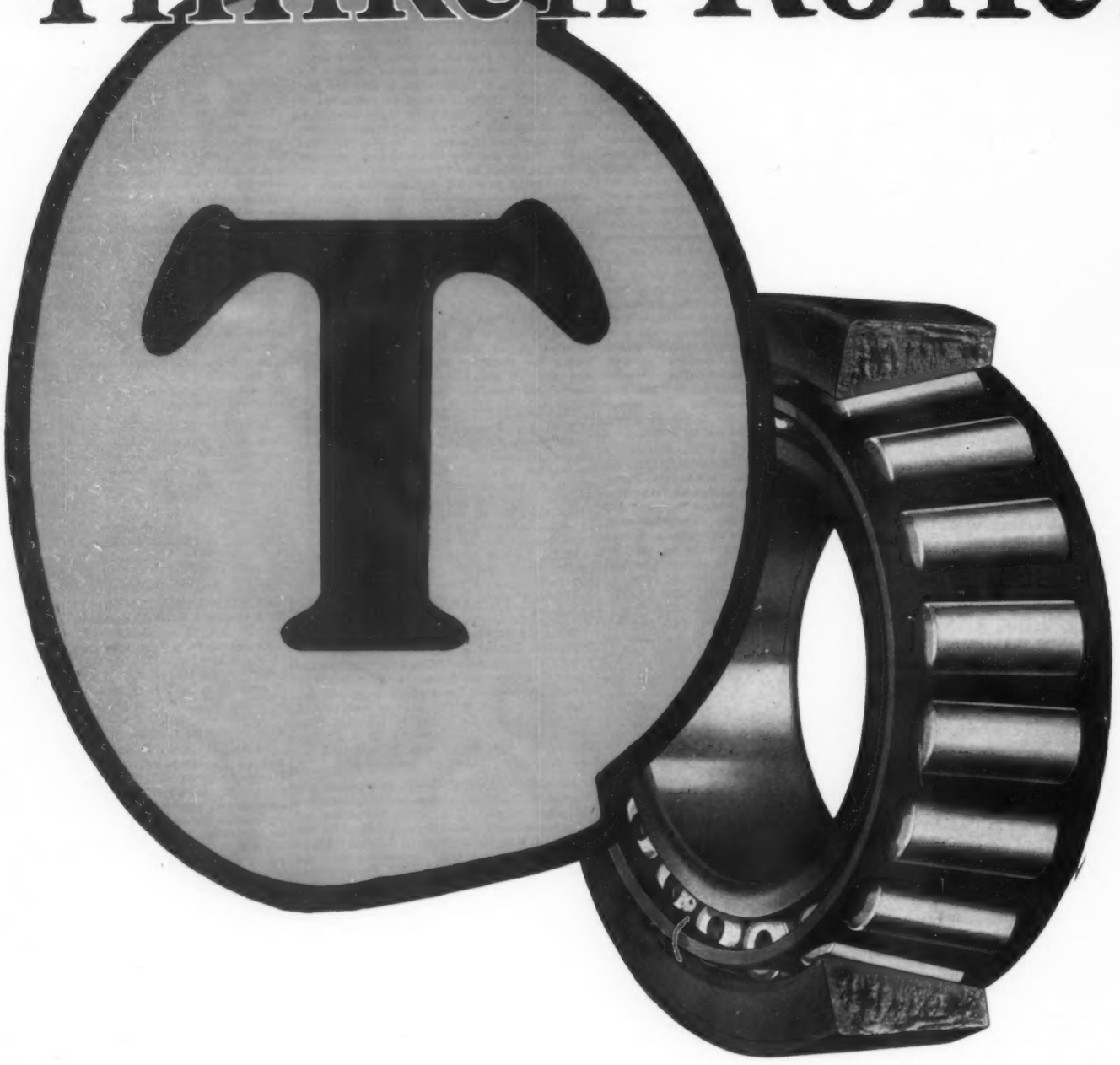
PUMP.—C. J. NOEL, Box 156, Orange Cove, Cal. The invention relates more particularly to pump head arrangements to be used in connection with double plunger pumps, in which two plungers work in the same cylinder one above the other, in opposite directions. This device is so constructed that the plungers are acted on by rocking beams in which the points supporting the plungers do not reciprocate vertically but along a circular curve. Means are also provided to convert this curve-like motion into a vertical motion before they actuate the plungers.

HAM-BONING DEVICE.—A. RAUBOLD, 45 Matilda Avenue, Bronx, N. Y. The object of the invention is to provide a simple rotatable machine which may be driven by power or hand operated and which may be readily adjusted to cut out or remove the bone of a ham of any desired size. A further object which may be manually actuated and manually adjusted during the operation so that the human element or judgment is present.

HOISTING APPARATUS.—LE ROY H. KIESLING, 1035 Gates Ave., Brooklyn, N. Y. The invention relates to a hoisting apparatus, primarily designed for use with dumbwaiters and hand-operated elevators. The object is to provide a simple and efficient device which has means in conjunction with the hoisting wheel for stopping its rotation

(Continued on page 128)

Timken Roller



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UPON dependable, available, economical service has the automotive industry builded so swiftly and so strongly.

Motor cars and motor trucks are built as well as the best engineering brains of the world can build them. The best raw materials and the best component parts go into the best designs that can be evolved. And yet the most perfect mechanical device will not run without service; any more than one's body will function properly without attention—without service.

When you need a Timken Bearing you get it easily and quickly. That is service. That is service that protects the users of Timken Bearings, safeguarding the automotive industry (and the specific manufacturer in the industry whose product you use).

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For six and a half years the economical distribution of Timken Bearings to owners, dealers, and garages has been made through a separate company organized for that purpose. Effective January 1, 1923, this organization, consisting of thirty-two main, direct branches, and approximately one thousand authorized distributors, will be under the direct operation of a new company, THE TIMKEN ROLLER BEARING SERVICE & SALES COMPANY, with headquarters at Canton, Ohio.

This far-reaching service, safeguarding the interests of motorists everywhere, makes Timken Bearings available within a few minutes, in every size, throughout the United States and Canada.

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Baltimore	Cleveland	Indianapolis	Newark	Philadelphia	Salt Lake City
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Know genuine Timken Tapered Roller Bearings by the standard package in which they are sold.

The Timken Service Catalog furnishes complete information regarding Timken Bearings.

Machines and Mechanical Devices

(Continued from page 125)

when the shaft on which it is loosely mounted ceases to rotate.

TWISTER.—J. S. BACHMAN, c/o Anchor Duck Mills, Rome, Ga. Among the objects of the invention is to provide a separator for keeping the many strands of yarn divided in the operation of twisting the strands into a thread. A further object is to provide the combination of the invention with the mechanically driven rolls of a twister.

BRAIDING MACHINE ATTACHMENT.—G. E. SWAN, 121 Lenox Ave., Providence, R. I. The general object of the invention is to provide means associated with the rubber strands of an elastic braiding machine for causing the operation of the means provided for connecting the braiding machine to the prime mover to release the former from the latter upon the breaking of the rubber bands. (See Fig. 8.)

JOINT.—R. M. SPENCER, Box 376, Roy, Mont. The invention relates to a joint, such as is commonly employed in connecting a drill and stem. The joint comprises a female and a male member connected by cooperating threads, the male member having an offset formed in its abutting face, and the female member having a series of indentations formed in its abutting face in registering position with the offset, whereby when molten metal is poured therein and set, the two members are positively locked against movement. (See Fig. 9.)

Medical Devices

COMBINATION BLOOD-PRESSURE AND RESPIRATION INSTRUMENT.—E. L. FISK, 25 W. 45th St., New York, N. Y. The invention particularly refers to sphygmomanometers and spirometers for determining blood pressure and respiration. At the present time these instruments are used separately. The principal object is to provide an instrument which combines with a sphygmomanometer a spirometer, whereby the same gage may be employed for measuring the blood pressure and respiration, thus eliminating the expense of two instruments.

HOLDER FOR DENTAL X-RAY FILMS.—L. A. J. HAWKINS, Jerome, Ariz. The invention relates to a device for positioning and holding dental X-ray films for the taking of photographs of given teeth in a set. The general object is to provide a device, and means to secure it on a tooth to have support thereon to thereby properly position the film for the taking of the particular teeth to be subjected to the X-ray.

Musical Devices

TIGHTENER FOR VIOLIN "E" STRINGS.—H. S. JACKMAN, 546 Edmund St., St. Paul, Minn. The general object of the invention is to provide a tightener of the indicated character whereby a direct pull is exerted on the string by the tightening device; the tightening is effected in a manner to avoid any tendency of the tightener to throw the tail-piece of the instrument out of position, and without scratching or injuring the instrument.

MUSIC LEAF TURNER.—F. HALL, Room 201, Y. M. C. A., Victoria, B. C., Canada. The invention relates more particularly to music leaf turners which may be operated by the foot of the player at the instrument. An object is to provide a means for turning the music leaves without interrupting the continuous playing of the instrument by the musician.

Prime Movers and Their Accessories

COOLING SYSTEM FOR INTERNAL COMBUSTION MOTORS.—F. WENDLING, 9317 87th Ave., Edmonton, Alberta, Can. It is the primary object of the invention to devise means whereby the liquid condensation due to the evaporation of the volatile liquids used in connection with the cooling fluid of a motor vehicle may be recovered. It is a further object to provide means whereby this liquid may be returned to the cooling system by automatically operated means, and to supply the motor with moistened air at a point in the intake manifold between the carburetor and the motor.

MIXER.—L. L. MONTGOMERY, 1916 Banks Ave., Superior, Wis. The invention relates more particularly to a mixer for use in connection with internal combustion engines, an object being to provide a mixer which can be conveniently located at various points between the carburetor and the engine to insure a thorough mixing of the gas. The mixer can be secured in place without changing the ordinary construction of the engine parts, and may be used single or in any desired number.

TIMER.—A. PAJALIC, 593 Continental Avenue, Detroit, Mich. An object of the invention is to provide a device of the above mentioned character which is positive in operation and insures the firing of the spark plugs of an internal combustion engine, at the proper instant. A further object is to provide a timer which is simple in construction consisting of few parts which may be easily disassembled for the purpose of renewing worn parts.

SPARK PLUG.—A. P. SWAIDMARK, 90 Oakland Avenue, Manchester, N. H. This invention has for its object to provide a construction in which the dielectric carrying one of the contacts may be reversed in such a manner as to double the life of the same. Another object is to provide a reversible dielectric for spark plugs in which a shoulder is provided near each end so that either end may be inserted into the plug for acting as the spark end.

PISTON CONSTRUCTION FOR INTERNAL COMBUSTION ENGINES.—J. M. FOUNTAIN, 31 Boyce St., San Francisco, Calif. The primary object of the invention is to construct a piston which is adapted to entirely eliminate any possibility of leakage of gas between the walls thereof and the walls of the cylinder with which the piston may be associated. It is also an object that the piston be adapted to substantially eliminate the necessity of removing the packing rings thereof.

Railways and Their Accessories

RAIL JOINT.—J. B. MURRAY, Wilmington, Ill. This invention refers to an improvement on a former patent by the same inventor, as mentioned in the SCIENTIFIC AMERICAN of December, 1922. The present device is primarily designed to provide a longer leverage to the two members, whereby a greater lifting force is exerted by the device when a train passes thereover. A further object is to provide a device in which only one bolt is used to secure the two members together.

Pertaining to Recreation

BASKET BALL TOY.—K. BENSCH, Bayport, N. Y. The general object of the invention is to provide a toy comprising a figure simulating a basket ball player and a basket positioned to receive the ball thrown by the figure when operated. A more specific object is to provide in connection with the figure, ball throwing means of strong and simple construction and positive in action.

GAME OF SKILL.—J. IRSCH, c/o Mrs. Fleckinstein, 601 5th Ave., Astoria, L. I., N. Y. The invention relates to a game of skill which is intended to be amusing when two or more play at the same time. Among the objects is to provide a game wherein steadiness of motion by the operator determines the chances of winning the game, and wherein all parts are visible so that a contestant may very readily see how his part and the parts of others are progressing.

BASEBALL GLOVE.—B. KENNEDY, c/o Ken-Wel Sporting Goods Co., Gloversville, N. Y. The invention has reference more particularly to gloves commonly known as fielders' gloves. An object is to produce an article of this class in which the tendency to rip between the fingers at their juncture with the body portion of the glove, when subjected to the strain of use, is obviated. Another object is to produce a glove in which added strength is given at the point of the base of the fingers, and to give better wear when the player brings the back of hand in contact with the dirt.

Pertaining to Vehicles

MEANS FOR SECURING TIRES TO RIMS OF VEHICLES.—D. MAGGIORA, Viale Le Fontanelle, Trespiano, Florence, Italy. The invention refers to a means for securing tires to rims of wheels, the tires consisting of the usual outer tire, such as those used with pneumatic tires, but instead of the air chamber there are arranged one or more cylindrical elements formed of several concentric India-rubber parts. The means of securing consists in the provision of metallic segments arranged between the edges of the tire, said segments being enlarged so as to maintain the edges in working position.

GUIDE.—I. A. ROMMER, 615 Saratoga Ave., Brooklyn, N. Y. The object of the invention is to provide a guide particularly adapted for use in connection with a motor vehicle by means of which an operator will be able to accurately determine the part of the forward wheels when the car is moving in a straight line, thus enabling the driver to follow and ride upon car tracks, avoid foreign matter, and holes upon the road, and to guide the vehicle to a point adjacent the curb in "parking."

AUTOMOBILE HEADLIGHT.—B. STERN, 47 Claremont Ave., New York, N. Y. An object is to provide a lamp which may be mounted so low upon the forward end of the car that the rays from the lamp will not annoy the drivers of approaching cars. Another object is to provide a pair of headlights capable of vertical adjustment so that they may be carried at different elevations in accordance with the pleasure of the driver of the car.

BAGGAGE CARRIER.—J. H. DYETT, 329 Hancock St., Brooklyn, N. Y. This invention has particular reference to a device which is designed to be associated with the running board of a motor vehicle. The principal object is to provide a baggage carrier which is adjustable in width, to accommodate baggage of various sizes, without the necessity of employing straps, ropes or other independent fastening means. The device when not in use may be folded into a minimum space.

TIRE.—V. KUBELKA, 89 McDougal St., Brooklyn, N. Y. This invention relates more particularly to a tire in combination with a rim comprising a solid tire body having an annular recess therein, and an annular chain of spring links supported on the rim and bearing directly against the inner surface of the tire body. An object is to provide a very strong tire of this character for trucks or heavy motor vehicles now using solid tires.

TIRE COVER.—F. T. BOHAN, 107 Somerset St., New Brunswick, N. J. The object of the invention is to provide a tire cover consisting of fabric bands which is simple and durable in construction, easy and inexpensive to manufacture, effective to encase and protect a tire and readily manipulated to receive and release the same, and is capable of continuous use.

RIM REDUCING AND EXPANDING IMPLEMENT.—J. R. ABERCROMBIE, Siloam Springs, Ark. The invention relates generally to rims supporting pneumatic tires, and more particularly to implements used in placing and removing tires from such rims, the object being to provide an implement which will not only reduce the usual split rim and hold the same in reduced position during the removal and replacement of a tire, but will also expand the rim to the normal position after a tire has been placed thereon.

SIDE-DUMPING VEHICLE.—C. A. DAVIDS, 2 E. 23rd St., New York, N. Y. The invention relates to a vehicle with a movable box adapted to turn laterally to the vehicle proper and then tip upwardly. Another object is to provide a construction in which a movable box is operated from the driver's seat, and in which the load will be delivered at one side of the vehicle without necessitating the vehicle backing up to the place on which the load is to be deposited.

NONSKID DEVICE FOR AUTOMOBILE TIRES.—R. H. and F. H. BACHMAN, 1127 Linden St., Allentown, Pa. Among the objects of the invention is to provide an anti-skid chain of a design such that the tire encircling chains are individually and detachably mounted, thus insuring the operation of the device even though one or more chains break, and permitting of the ready adjustment of chains to replace broken ones, and enable the use of any desired number of encircling chains from one to the full number required for the entire circumference.

RESILIENT WHEEL.—E. COHN, 404 Audubon Ave., New York, N. Y. The invention has reference to a wheel of the type in which a cushion of air contained in the cylinders having pistons is used to furnish the proper resiliency between the hub and felly of the wheel. An object is to provide a simple and compact structure in which the cooperating of the various parts connecting the hub to the felly of the wheel is effected with a minimum amount of shock to the wheel and wear to the parts.

ANTI-SKID CHAIN.—R. BRIGGS, 245 W. 6th St., Salida, Colo. This invention has for its object to provide a fastening device for the end links of the side chains, which hold the anti-skid chains in place. A further object is to provide a device which in addition to holding the several parts in set position, is simple in construction, durable and inexpensive to manufacture.

WINDOW SILENCER.—H. P. HANSON, Cambridge, Minn. An object of the invention is to provide a device to prevent the rattling of automobile or other vehicle windows, such device having means for engaging the glass pane to prevent vibration and thus eliminate noise. A further object is to provide a device of this character that can be applied to an automobile of any ordinary construction without any change in the construction of the car being necessary.

LUBRICATING SYSTEM.—O. C. BALDWIN, Box 231, Winfield, Ohio. An important feature of this invention is the providing of a device which is constructed to be placed over the ordinary opening in the transmission case so that the original construction of the case and cover is not altered. The device will collect the oil from the flywheel within the casing whereby the oil will pass through a strainer, thence into the crank case; it is particularly adapted for use on Ford cars.

COIL BOX PROTECTOR.—F. P. LIDE, Lee St., Decatur, Ala. This invention relates to coil boxes for automobiles and like vehicles. An important object is to produce a device of this character which will effectively protect the wires within the hood from water or the like. A further object is to produce a protector of this type which will be simple in construction and inexpensive to manufacture.

PRESSED STEEL FRAME FOR MOTORCYCLES AND LIKE VEHICLES.—G. CALVIGNAC, 49 Rue Lannois, Levallois, Perret, France. Among the objects of the invention is to provide a frame made of pressed steel, the said frame being constituted of two symmetrical plates which are conveniently connected with each other, so as to obtain a rigid resisting structure, the same being shaped so as to receive the motor and its accessories.

WIND-SCREEN OF MOTOR CARS AND OTHER VEHICLES.—M. EYQUEM, 191 Boulevard Pereire, Paris, France. The invention has for its object to provide a rigid mounting for the rear wind-screens of motor cars and other vehicles, to afford an efficient protection for passengers occupying the rear seats. The mounting is characterized by the feature that when the screen is in its position of use, the screen itself has a direct bearing upon a fixed point forming part of the vehicle, this fixed point being independent of the apparatus for opening or moving the wind-screen.

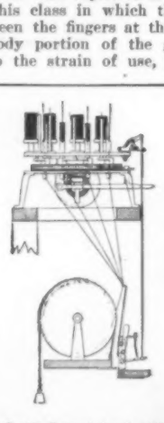

Fig. 8: Novel attachment for braiding machine designed by G. E. Swan

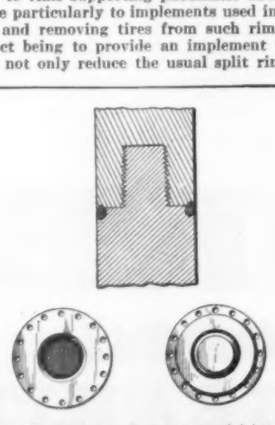

Fig. 9: R. M. Spencer's new type of joint for uniting drill and stem, etc.

Science Notes

Death of W. H. Hudson.—We regret to note the death of Mr. W. H. Hudson, one of the most popular writers on Natural History which England has ever produced. He had the rare knack of picturing nature blended with pleasant stories.

Wooden Houses Best for Earthquakes.—A Japanese seismologist states that Japanese wooden houses are safest in earthquakes. He pointed out that the most dangerous structures are brick buildings. He considered ferro-concrete buildings as safe.

Mendel Celebration.—A centenary celebration of the birth of Mendel took place at Brünn, Czecho-Slovakia, in September. A monument was erected at this place in 1910, and in the succeeding 12 years the fundamental significance of the principle which he discovered has been widely recognized and applied in biology.

Soudan Expedition.—The French Museum of Natural History is sending one of the best equipped exploring parties which has ever left France. The party will be in Africa for two years, and they will catalog all the flora and fauna of the French Soudan, the Ivory Coast, Guinea and the other territories. The natural resources of these colonies will also be examined with great care.

A Curious Method of Time Computation.—When the explorer, Harry de Windt visited the Siberian Ostiaks he found that they calculated quite long distances in terms of "kettles," an almost identical custom at the other end of Asia. If a journey was five kettles long, the traveler found they meant that it would take as long as it would to boil five kettles of cold water in succession.

Herschel Centenary.—The centenary of the death of Sir William Herschel was recently celebrated at Slough, where he carried on many of his researches, assisted by his sister Caroline. This is one of the most romantic episodes in the history of astronomy. The large reflector is still preserved, as are other interesting relics which are kept in the old barn where many of his astronomical observations were made.

Robbing Snakes for Serum.—A short time ago poison was extracted from 33 snakes, at the Bronx Zoological Park, for making a snake serum. The call for this serum has been increased by the difficulty in getting whiskey as an aid in the treatment of snake bites. Whiskey is not only difficult to obtain at the present time, when wanted in many sections of the country, but it has no efficacy in curing snake bite.

The Drys Wreck Poevrotherium.—It is ludicrous to think that the camel, that symbol of aridness, should have been the victim of dry agents. Still, it was not a camel either, it was a long, long-time-ago ancestor of the camel, known as a "Poevrotherium." A sheriff thought that the skeleton, which was uncovered by a scientific expedition, was a device for concealing bootleg liquor, and in his search he destroyed this very fine paleontological specimen. Evidently his zeal for dryness was greater than his geological attainments.

Poison of the Borgias Still Operates.—What is thought to be the poison of the fifteenth century Borgias has been transmitted to a curio collector at Zurich with serious effect. The collector recently bought a ring in Turin made in the form of a serpent and guaranteed to be of the Borgia period. After wearing the ring, he found his finger and forearm had swollen. A doctor declared poisoning had set in and was due to the ring. A small hole was found under the serpent's head, and from this the poison was emitted, but time had weakened its strength.

Modification of the Metric System.—According to a recent issue of the *Decimal Educator*, the official organ of the Decimal Association, the association proposes to concentrate its efforts for the time being on securing an alteration of the value of the pound weight from 454 to 500 grams; that is, half a kilogram. The ounce of 16 to the pound would in the first instance be retained, so that 4 ounces would be 125 grams. The new ton would be 2000 new pounds, equal to the metric ton and a little more than 15 per cent greater than the present ton. All denominations between the pound and ton, such as hundredweights, quarters, and stones of all kinds, would be eliminated and intermediate weights expressed in pounds.

The Imperial Bureau of Entomology.—This Bureau was established in 1913 to en-

courage and coordinate entomological work throughout the British Empire, in relation to human, animal and plant diseases. During the last year 53,000 insects have been submitted for identification—this collection, of course contained in many cases more than one specimen of a single species. The Bureau also issues two valuable periodicals; one a quarterly, of which a recent number contained nearly 500 pages, and the other is a review of applied entomology, which is brought out monthly in two series; one dealing with insects injurious to plants, the other with insects that disseminate human and animal diseases. More than a thousand periodicals are abstracted by the staff of the Bureau.

A Cageless Zoo.—Detroit is following the example of Rome in having a cageless "zoo." In the Detroit Zoological Society the animals will live, sleep and eat in the open. The limits of their domains will be marked by deep chasms of artificial rock, and if the lion or tiger jumps too far he falls to the pit below and is unable to get out. Experience has shown that after one or two such falls the animal cares little for a repetition of the experience. The size of these open spaces in the new zoo are to be, of course, governed by the habits of the animals and the distance they can leap. A tiger, it is said, will be given a space of about 40 feet; a lion 30 to 35 feet, and a bear a much shorter distance. The snakes and other reptiles which would crawl their way out of rock pits are kept in the usual manner. Credit for the innovation is due to Secretary of the Navy Denby.

Cooked Fish from an Italian Lake.—Quantities of dead eels, gray mullets, seabass and other fish have recently come to the surface of Lake Lucrin, near the north shore of the Gulf of Naples. Fishermen in the vicinity were delighted, especially as the fish appeared to be already cooked, but the authorities prohibited collection of the fish, fearing that they had been poisoned by an eruption of gases. It was these gases, the authorities explain, which, evidently coming from the bottom of the lake, made the water bubble and boil, thus killing and in a way semi-cooking the fish. Lucrin is a small lake said to have been formed by volcanic action in prehistoric times. It was well known for its fish in Roman times, and writers of antiquity extolled its oysters and mussels. Near this is the famous *Lacus Anemus*, regarded by the ancients as the entrance to the infernal regions.

Exploring British New Guinea.—A scheme is on foot to explore British New Guinea, the interior of the island never having been traversed by a white man. The *English Mechanic* has recently had some interesting particulars relative to this expedition, as follows: The aim of the expedition is to determine the economic value of New Guinea to the Empire, and to add to the sum of scientific knowledge. It is hoped to send out an advance party to select a suitable harbor as a base of operations. For the main expedition the personnel will include experts in entomology, botany, geology, mining, engineering, anthropology, chemistry, archaeology, tropical agriculture, and topographical surveying. The non-technical staff will number eight, but so exacting are the conditions that out of 714 applications, only three have been found to comply with them. The party will number 30 all told, with a police protection of 100.

The Jumping Stick Again.—A curious tale comes from Paris by way of the Academy of Science. This is a "jumping stick from Para." The animated bit of wood is a dead branch of a walnut tree, and from its antics it would seem to be a relative of the Mexican jumping bean. The branch is over three feet long and is one-half inch thick, and suddenly moved across the court of a public school at Nantes as if carried by the wind, although there was no breeze at the time. Then it came to a sudden halt and leaped several feet in the air. Again it moved along the ground, leaped into the air, and marched in another direction. When, finally, after an hour's vigorous and eccentric exercise, it came to rest it was 20 feet from its starting point. Observers carefully examined the branch but found no trace of exterior manipulation connected with its movements. A long paper on the incident is now being prepared and will be read before the Academy of Sciences. The only explanation of the "jumping stick" so far advanced is that it is a phenomenon of hypsometry or of elasticity.

Butler's Painting of the Northern Lights.—Mr. Howard Russell Butler has

on several occasions painted Bald Head Cliff near Ogunquit, Maine. The artist was revisiting the region and under the spell of its old-time appeal to him, decided to make one more nocturnal painting of the cliff. He set to work on his sketch, favored by a cloudless sky in which the "Queen of the Heavens" shone in full splendor. Mr. Butler had completed his foreground, and was resting, entranced with the scene, his sketch board and colors at hand, when the first light of an aurora borealis appeared. Seized by an inspiration, the artist immediately extended his sky, changing his picture from a horizontal to a vertical one, and had the good fortune of transferring to canvas a record of one of the most magnificent auroras that have ever been seen on the coast of Maine, where brilliant manifestations of the northern lights are frequent. The result is the beautiful painting now on exhibition at the American Museum of Natural History and is also reproduced in colors in their journal *Natural History*.

A New Vegetable.—The dasheen, introduced into the South a few years ago from the tropics, is gradually increasing in popularity, and the annual shipments to northern markets are now about 10 carloads. It is estimated that between 2000 and 3000 farmers and gardeners, mostly in Florida, grow this new potato-like vegetable and use it on the table. The United States Department of Agriculture has been carrying on experiments in the growing of dasheens and has prepared them in many different ways. The department does not expect the tuber to take the place of the potato except perhaps where it is obtainable at lower cost, but it is a wholesome and nutritious vegetable that grows exceptionally well in certain localities. For this reason the department believes it is well worth developing. The new vegetable will furnish a pleasing variety to the diet. Although the composition of the dasheen is much the same as that of the white potato, it contains less water and consequently a higher percentage of protein and carbohydrates. Recipes may be had by writing to the Department of Agriculture, Washington, D. C.

Humane Societies One Hundred Years Old.—Humane societies are celebrating the fact that laws for the protection of animals have been in existence for 100 years. In 1822 an Act of Parliament was passed in England which provided for a punishment for the "ill treatment of cattle," and the act was introduced by a man named Richard Martin, who was called "Humanity Martin" because of his introduction and support of this law. Naturally the passage of the bill brought a great deal of opposition. The opponents wanted to know why the punishment should not be inflicted for boiling lobsters and eating live oysters. Martin not only passed the law but was the first complainant under it. He found a driver who was mercilessly beating a donkey. The poor animal was dragged into court, and very much to the surprise of the courtroom crowd, the driver was found guilty. Two years after the passage of the Act Martin organized "The Society for the Prevention of Cruelty to Animals." Queen Victoria later approved of the organization and added the word "Royal" to the title, and we derive our own American Society for the Prevention of Cruelty to Animals from this excellent example.

The Shenandoah Caverns.—The exhibition of caverns to the traveling public is noted by the United States Geological Survey as a growing industry in the Shenandoah Valley of Virginia. The famous Valley Pike, now a link in the New York to Atlanta highway, is traversed yearly by thousands of automobile tourists properly intent upon seeing America first, and no one has adequately seen America who has not visited one or more of the caverns in the Shenandoah Valley. Until recently the only caverns that were accessible to the public were the celebrated Luray Caverns in Page County, and Weyers Caves in northern Augusta County, near Grottoes. However, within 12 months, the Endless Caverns, near New Market, in Shenandoah County, have been thrown open to the public, and on May 31 another cavern near Mount Jackson, also in Shenandoah County, made its first bid for public favor. The latest-opened caves have been named Shenandoah Caverns. They are about three miles south of Mount Jackson and two miles west of the Valley Pike, with which they are connected by a macadamized road. They are close to Shenandoah Caverns station, on the Harrisonburg branch of the Southern Railway, and are readily accessible both to the automobilists and to the railway tourist.

Miscellaneous Notes

A Divided Screen.—The movie theaters in Java are so constructed that the screen divides them into two parts, the Europeans sitting on the side from which the picture is produced and the natives on the other.

Butter Packages.—At the National Dairy Show held in St. Paul during October, the United States Department of Agriculture had an unusual exhibition of butter packages, both home and foreign, with examples of good and of poor packing.

Sentenced to Read "Black Beauty."—As a fine for alleged overloading of his horse-drawn wagon, James O'Donald, president of a local teaming company, was sentenced recently to read "Black Beauty" by Municipal Judge John F. Haas.

The Little Purple Stamp.—Our Government film, "The Honor of the Little Purple Stamp," is now showing English meat handlers and consumers how freedom from disease is guaranteed for all meat products shipped to them from the United States.

When Sugar Was a Luxury.—In the middle ages sugar was known as "Indian Salt," and was used only by physicians and by the very rich. In Colonial days sugar was also a luxury, but became a staple article of food when tea and coffee began to be used.

A High Chair for the Soda Fountain.—A New York soda dispenser has made it easy for the small child to imbibe an ice-cream soda by providing a specially constructed high chair which relieves the parent of the burden of holding the child up to the counter, or stooping over to feed the little one.

Wire Glass for Windows of Taxi Patrons.—Excited passengers who are afraid of being carried past their destination, or who are afraid of wrong turns, have broken so many of the glass windows behind the driver that we now find wire glass used instead of ordinary glass. This will resist pounding much better than does the plain article.

Fool Examination Papers.—The United States is not the only country that has fool examination papers for the bedeviling of ex-service men. One English soldier in answer to the question, "How far is it from the earth to the sun?" replied, "I cannot say the exact distance of the sun from the earth, but it is not sufficiently near to interfere with my properly discharging the duties of my office."

Economy Strikes Berlin.—Berlin is bedeviled with exacting servants who will not work longer than eight hours, so that a servant is a luxury in a Berlin household. This has resulted in a great development in devices which will tend to do away with the labor of maids, and the vacuum cleaner, electric washing machine, and other labor-saving devices are very much to the fore at the present time.

A 12-Pound Melon Sent Unwrapped Through the Mails.—What the Postmaster of Las Cruces sent to the Postmaster General was a 12-pound honeydew melon, which went safely through the mails unboxed and unwrapped. The name was neatly typewritten on a small band of paper, which was glued to the melon. It certainly shows the efficiency of the parcel post when a delicate melon of this kind can be sent by mail. The postage was $1.05, the weight being 12 pounds.

Safety Coupon Rooms.—A New York bank recently installed a series of so-called "coupon rooms," which have some elements of novelty. Each visitor desiring to examine the contents of his or her safe-deposit box has access to a small room, the door of which locks automatically, opening from the inside only. As soon as the visitor has left the room to return the box to its place, the door locks and remains permanently closed until the room is examined for lost articles by an employe. Many thousands of dollars in valuables are said to be lost annually in safe-deposit vaults by careless people who leave things behind after examining their boxes.

Pay of the Old Masters.—Modern artists are often prone to complain of their small income, but as a matter of fact Michelangelo received $32 a month. Leonardo da Vinci received about the same, and Raphael a trifle more. Strange to say that the earlier masters seem to have received just as much. Cimabue, who was a very early and primitive master, was paid a dollar a day and had to share his income with an assistant. Of course, these figures are

Some Gas Bill.—Think of gas at $6, $7, $8 and $9 a thousand cubic feet! That's what the housewives residing in many American cities had to pay a little over 50 years ago. And instead of complaining at the size of their gas bills, they were glad to have service so cheap. Here are the "cheap" rates charged in those days: Memphis, $5.50; St. Louis, $4.50; Nashville, $4.50; Mobile, $5.00; Atlanta, $5.50; Savannah, $6.00; Norfolk, $6.00; Vicksburg, $6.00; New Orleans, $4.00; Charleston, $7.00; Montgomery, $8.00; Macon, $8.00; Galveston, $8.00; San Francisco, $6.00 and Sacramento, $9.00. Compare these rates—the average of which is $6.20 per thousand cubic feet—with those charged today, keeping in mind the fact that 50 years ago there was only one use for gas—lighting—whereas today there are more than a thousand separate uses.

New Cane Planting Machine.—A cane-planting machine, invented by an American planter of Mindoro, was recently very successfully demonstrated, according to the *Manila Bulletin*. This machine plants two rows of cane at a time, throwing out the furrow, subsoiling the bottom, and packing the earth over the roots. Economy in labor is claimed to be one of the chief recommendations of the planter. It seeds from 5 to 6 hectares per day (1 hectare equals 2.471 acres), which not only effects a big saving but also makes for uniformity of growth. There is also said to be a substantial saving of seed, and the machine eliminates a loss which has occurred in hand planting; that is, it gets the cane into the ground while the roots, started by soaking the cuttings, are fresh and vigorous.

Many Products Now Made from Peanuts.—The commercial production of peanut oil, which has developed rapidly since 1915, has resulted in the appearance on the market of large quantities of by-products that are used principally as feeds for livestock. One reason for the phenomenal growth of the industry is that the peanut can take the place of cotton as a cash crop in regions where the boll weevil has made the growing of the fiber crop unprofitable. The peanut has been a boon to the oil millers as well as to the planters for the oil is produced in the same mills that are used for extracting cottonseed oil. The principal products other than the oil are peanut-oil cake, which is defined as the residue after extraction of part of the oil by pressure or solvents from peanut kernels; peanut-oil meal, which is the ground peanut-oil cake; and unhulled peanut-oil feed, which is the ground residue obtained after extraction of part of the oil from whole peanuts. The ingredients of the last-named feed must be designated as "peanut meal and hulls." Theoretically peanut-oil meal, which is made from the kernels after a part of the oil has been extracted, should contain no hulls, but because commercial methods cannot remove all the hulls it is necessary to permit a small amount of hulls in the meal in order that the definition may be practical.

Russians, Make Your Letter Short.—Citizens of Russia when writing to America should not leave anything unsaid in their first letter. Under the new rates of postage between the United States and that country, it costs 200,000 rubles to mail a letter weighing less than an ounce, according to a recent communication received at the Post Office Department from the Universal Postal Union. Post cards cost 120,000 rubles each for mailing, while other articles "at the reduced rates," may be mailed at the rate of 40,000 rubles for each two ounces. These rates represent the equivalent, it is explained, of 50, 30 and 10 centimes gold, respectively. Temporarily, the old postage stamps with the value stated in copecks gold, are put into circulation, under the following conditions: Postage stamps with the nominal value of one copeck up to 14 copecks are increased in value a million times. For example, the actual value of a 7-copeck postage stamp is equal to 70,000 rubles. Postage stamps with the nominal value of one ruble up to ten rubles are increased in value ten thousand times. For example, the actual value of a 5-ruble stamp is equal to 50,000 rubles. A ruble normally corresponds to an American half dollar and was the old standard currency unit in Russia. Today it would take nearly two hundred pounds of one-ruble notes to mail a letter to America.

Mechanical Engineering Notes

Lapping Comparisons. — Photomicrographic comparisons of lapping done by hand and by machine have recently been exhibited, and have aroused much interest. The outstanding feature seems to be that in the hand-lapped pieces the scratches run quite promiscuously in all directions, while in the machine-lapped work they are substantially parallel.

Renovating Oil is one of the relatively new ideas that has made big progress. All water, dust, grit and metal particles can be removed from lubricating oil, and at the same time the life of the oil is greatly increased while lubrication is vastly improved. The same technique is available with cutting oils, hardening oils, and even fuel oils, and greatly increases their serviceability.

For Sounding Small Holes a very neat tool has recently been put on the market. A spring inside the barrel of the tool forces a thin rod down until it is stopped by the bottom of the hole or recess to be measured. A quick turn of the clamp screw then sets the rod in this position, and the tool is withdrawn, for gaging of the projecting rod-length to as great accuracy as desired.

Truing Crank-pins of stationary engines or locomotives is an expensive job when the pin has to be dismounted and taken to the machine shops. The railroad machinist knows that there are machines available for doing this truing on the engine, without removing the crank-pin; but the man who is called upon to overhaul a stationary engine may not be quite so familiar with this possibility.

Snap Gages with the outer frame in the form of a bridge truss, carried around over the semi-circle by several straight sections instead of a continuous curve, and with open spaces between the ribs of the truss, are the latest wrinkle in accurate gaging. It is claimed that though lighter than the conventional gage with solid, curved frame, they are considerably stronger; that their rigidity is much greater; and that the broken lines of the outer rib give a sure hand-hold even when the gage is covered with oil.

The Growth of Die-Casting within the past decade has been remarkable. Today die-castings are produced of attractive appearance, strong enough for any reasonable use, and much cheaper, especially when produced in quantity and when of reasonably complicated shape, than forgings or castings that have to be machined to size. When it is realized that holes and even threads can be provided with sufficient accuracy to require no subsequent sizing, the large place which the die-casting has come to hold in present-day machine practice is understood.

Simpler Machines.—There seems no doubt, says *American Machinist*, that the craze for strictly single-purpose machines is on the wane. Just how much it was justified and how much a total economic waste we shall never know, but we are getting back on a rational basis. But in so getting back, there is a decided tendency on the part of large users of machine tools to demand simple tools. Not for machining a single piece, be it understood, but to perform a simple operation, such as gear cutting, on a simple machine. As an example, a gear cutter recently developed is mentioned, which contains, itself, only four gears. The reduction to this number from 27, 30 or even 35, is attained by reducing the range of the work, but still the machine is sufficient for quite a variety of gears.

Hardening Steel Without Scaling.—Processes for hardening steel without scaling have had much attention in England during recent years. One of the most successful hardening furnaces that meets these requirements is that made under the Walters patents. In this furnace the work is suspended in a vertical tubular muffle heated by an electric resistance winding of nichrome. The atmosphere in the heating space is coal gas, which is admitted to the lower end of the muffle and escapes slowly through an outlet near the top. The atmosphere therefore is non-oxidizing and in fact, slightly reducing. When the work has reached the required temperature, it is dropped straight into a quenching tank without coming in contact with atmospheric oxygen. The result is a surface quite free from pits or scaling. At present the furnace is in use chiefly in toolrooms and for laboratory purposes, but larger furnaces have been used with great success in the hardening of crankshafts, rolls and other heavy work up to 200 pounds.—*Machinery.*

Civil Engineering Notes

British Rail Rearrangement.—Following more or less in the footsteps of the ill-fated American railroad administration, the British are now discussing a project for the realinement of all their roads into several large systems.

Electricity in Burma.—An extensive scheme is in contemplation for diverting the Yunzalian River, sending it down a slope and through tunnels, and supplying current for power and light to be transmited to Rangoon.

Iron in Malaya.—Reports come from the Straits Settlements of the discovery, by Japanese concessionaires, of hematite and titanic iron ores in Johore. A large hematite deposit has been located in Perak as well, but local transportation difficulties are hampering the effort to develop it.

Staggered Rail Joints are at the moment the subject of keen discussion in British technical papers. One authority claims that the staggered joint as used in America causes train swaying. British self-satisfaction is keen at the discovery of a considerable volume of American opinion in favor of the British system of opposite joints.

Crossing Protection.—That a certain type of driver is determined to get himself killed in spite of every measure that may be taken for his protection is indicated by a recent accident in the Chicago district. The crossing in question was protected by manually operated gates, a visible and audible wigwag signal, a loud-sounding bell, a stop sign, and a conventional railroad-crossing warning sign. The lay of the land is such that an approaching train is plainly visible from the road for a considerable distance from the crossing. Nevertheless, in clear weather a taxicab driver drove through the gate and on to the track, to be struck by a train and killed with one of his passengers. Accidents of this character lead one to speculate whether the matter of crossing protection is not a little bit overdone.

Heating Electric Trains.—In connection with through traffic across Switzerland, it has been found necessary to install some means of heating, with steam, international trains while they are being hauled through Swiss territory behind electric locomotives. On the all-Swiss trains electric radiators are used, but these are, of course, not available for trains that cross the border and take on steam locomotives. Electrically heated boilers have been put in, of a type specially adapted to the requirements of the situation. This boiler is installed upon a special coach, which is coupled to the train at the Swiss frontier, and dropped again when the farther boundary is reached. For economy the 1500-volt current of the overhead line is used without transforming, but this makes insulation at once more important and more difficult.

Simplified Paving Brick.—The Bureau of Standards has just published the results of a recent conference of the trade looking to elimination of unnecessary variety of shapes and sizes. The fact that very little impetus is needed to put through a really meritorious project of this character is indicated by noting that it took less than six hours' discussion to reach an agreement eliminating 55 out of the 66 existing varieties; and that at a later meeting the remaining eleven were further reduced to seven. Paving brick will hereafter be made only in sizes 3 by 4 by 8½, 3½ by 4 by 8½, 3½ by 3½ by 8½, and 3½ by 3 by 8½ inches, with certain of these sizes made up in different styles so that there are in all the seven varieties mentioned. It will be noted that all bricks, without exception, will be 8½ inches long.

Ship vs. Dock.—The fact that the "Majestic," 915 feet long, had to go to Boston in search of the only dry-dock in the world capable of landing her suggests a further limitation upon the length of giant liners than had been visualized in the mere exigencies of ordinary pier service at the ends of trips. A British contemporary points out the further complication that, though another dock of sufficient length now stands on the Elbe, awaiting transport to a point where it can be used, there is no project under way to put it into service, since no British port has a place where it could be placed in service. The custom of two or three super-ships would hardly warrant the expenditure for a special dry-dock capable of serving them, and this is probably as good a reason as any why the tendency of present-day design is against such monsters as the "Majestic," "Leviathan," etc.

Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Vancouver Radio Station.—Latest advices are to the effect that the Canadian Marconi Company, in cooperation with the parent company in England, is contemplating the erection at Vancouver of a radio station which will permit direct communication with Australia. This would be one of the largest and most powerful radio stations in the world and would probably cost $2,000,000 or more.

Radio Broadcasting in Cuba and Porto Rico from recently established stations is attracting much attention, according to recent *Commerce Reports*. The Cuban station is of 400-watt capacity and sends out a 400-meter wave with a range of 2400 miles. Broadcasting from Porto Rico began towards the end of last summer, from a 250-watt set. The latter broadcasting station has been heard at points 2000 miles distant.

Radio Business Today is proceeding at the rate of from 50 to 60 million dollars a year, according to an official of the Radio Corporation of America. "Experience has shown," states this official, "that the department store is not making a success of radio. Some music stores have done a good job, but the electrical man has proved himself to be in the best position and will carry away the business if he sets himself to sell complete units by progressive merchandising methods. The sale of parts will continue to the amateur experimenter, but there will be separate fields for development."

Radio Telephony in the West Indies.—The West India Committee announce that a system of radio telephony has now been successfully established in the British West Indies. The group benefited by this means of communication is the Turks and Caicos Islands, Grand Turk being now connected up with South Caicos and Salt Cay, distant twelve and eight miles, respectively. By this radio telephone the Commissioner is now able to converse with officials in the neighboring islands. The system can also be used for radio telegraphy, of course, and has already proved of great value in enabling the people of Grand Turk to know when steamers are approaching or leaving Santo Domingo for their shores.

Marconi's Calling Device.—In a recent issue of the London *Electrician* appears a description of the Marconi radio calling device which depends essentially upon the transmission of a series of Morse dots on a 600-meter wave length, at the rate of 3 per second, and the effect of these dots on the receiving apparatus is cumulative. In ordinary radio operation it is not likely that even eight consecutive dots would be received in this way, but in order to ensure practical freedom from accidental operation the number of dots selected has been fixed at nine. The transmitter of this calling device serves to send out the dots. For receiving these signals a three-tube amplifier and tuning circuit are provided. In addition, an oscillating relay is provided which is adjusted so that its normal period of swing is the same as that of the transmitting wheel. The oscillating member of the relay is set into operation, and each swing is of greater amplitude, until at the ninth swing an arm makes a contact and closes a local circuit containing an electric bell or other signaling means.

Underground Radio for Miners.—Experiments were recently conducted at Bruceton, Pa., by the Bureau of Mines, in conjunction with the Westinghouse engineers for the purpose of determining the adaptability of radio communication to mine rescue work. Signals were distinctly heard through 50 feet of coal strata, but audibility fell off rapidly as this distance was increased. With a receiving instrument 100 feet underground signals from a station 18 miles distant were distinctly heard, but an iron pipe, containing electric light wires, which extended therefrom through the mine, assisted greatly in the reception. The fact that signals were detected, even though faintly, is looked upon as sufficient to encourage further experimentation. The transmitter used sent out continuous waves of 200 to 300 meter wave length. In all experiments vertical antennae were found to give the better results. Horizontal antennae gave practically no reception. A loop of a single turn was used with fair results. The strata at the experimental mine lie almost horizontal. The mine is a comparatively dry mine, but the overburden is damp, and a small stream of water is continually flowing from the mine.

Free Medical Radio Service for Ships at Sea is announced in a recent communication from the United Fruit Company, from its hospitals in the various countries of Central America and from its passenger steamships. So far as the United Fruit Company and its subsidiary companies are concerned, this service is available without charge to ships of all nationalities through the radio stations operated by the United Fruit Company or the Tropical Radio Telegraph Company. Radiograms requesting medical advice should be signed by the captain of the ship and should state briefly, but clearly, the symptoms of the person afflicted. This free medical service is established primarily for the benefit of ships not carrying doctors; however, should occasion require, ships' doctors may hold consultation by radio with the United Fruit Company ships' doctors and hospital staffs. It is requested that when sending medical advice radiograms, radio operators check them "(number of words) DH Medico." These "DH Medico" radiograms will be given preference over all other radiograms, excepting SOS calls, throughout the radio service of the United Fruit Company and subsidiary companies.

Trans-Atlantic Transmission with Vacuum Tubes took place recently when an experimental high-power tube set at Radio Central, Rocky Point, L. I., was operated continuously for 16 hours, handling commercial traffic with Great Britain and Germany on a wave length of 19,000 meters. The set itself is for the time being composed of three 50-kilowatt, 15,000-volt, water-cooled, metal vacuum tubes, known in the engineering world as kenetrons, used as rectifiers, and six 15,000-volt, 20-kilowatt, water-cooled, metal pliotrons, used as high-frequency converters. For the experiment with the tube set one of the several radially-arranged antennae, each more than 1½ miles long and supported by six towers, was employed. A current of 350 amperes was delivered at the antenna circuit. The British Marconi Company have in their station at Carnovan, Wales, a tube set made up by parallel 60 air-cooled, fragile, glass vacuum tubes of approximately two kilowatt input capacity each. The American engineers have reduced the number of tubes necessary for a set from sixty to six, by increasing their individual capacity from two kilowatts each to twenty kilowatts each.

Dry Cell Vacuum Tubes.—The greatest change that has been brought about in radio of late is the growing popularity of the dry-cell vacuum tube known as the WD-11. This tube, which is now available on the open market, was formerly supplied only in connection with a well-known type of regenerative receiving set, the main feature of which was its vacuum tube operating on a single dry cell and a small "B" battery. The WD-11 eliminates the costly and troublesome storage battery and substitutes in its place the simple, inexpensive dry cell. This tube, contrary to widespread belief and unfounded claims, is available in only one model which, however, works quite well as a detector or an amplifier. Distances quite as great as those covered with the usual storage battery tubes are now being spanned with the WD-11. The filament of this little tube is of platinum wire, coated with an oxide for the production of a profuse flow of electrons with a minimum temperature. The filament, which should not glow brighter than a dull red, consumes about a quarter ampere. A single 22½-volt battery unit will prove satisfactory in the plate circuit, but for amplification the potential may be raised to 80 volts if desired. The WD-11 enjoys remarkable freedom from tube noises. For detection, it should be used with a grid condenser of .00025 mfd., as well as a grid leak of 2 megohms.

Archaeological Notes

Ancient Carthage in the Hands of Speculators.—The site of ancient Carthage is being sold off and divided into building lots, and the surrounding hills, rich in history, are being slowly covered with residential villas.

Excavation on the Sea of Galilee.—Part of an ancient wall and columns belonging to the ancient city of Tiberias on the Sea of Galilee have been recently recovered. As soon as the ruins were discovered expert archæologists were summoned and the excavations will be carried out under scientific control. It was near this city that Jesus preached his Sermon on the Mount, and Mary Magdalene is believed to have come from a near-by town.

Carving on Lebanon.—On the face of a cliff in the Lebanon hills Rameses II, King of Egypt, well over 3000 years ago ordered his stone carvers to inscribe a tablet setting forth his conquest of the land. The figures of the ancient Egyptian ruler and his men still are visible. A few feet away one may see, carved in the same rock by a British stone cutter, a record of the coming in September, 1918, of Field Marshal Sir Edmund H. H. Allenby, G. C. B., commander of the allied forces in Asia Minor. And the passage of the centuries from B. C. 1300 to A. D. 1918 is recorded by a dozen other carvings, each describing the march of a victorious army.

The Origin of the Swastika Symbol.—The subject of the origin of the Swastika symbol has given rise to protracted controversy. The latest contribution to the question is that of Harit Krishna Deb in the *Journal* of the Asiatic Society, Bengal. He suggests that it is a modification of the mode of expressing the ancient Hindu syllable Om, which is used in religious rites. This, a pothook with square ends, was duplicated, one across the other, to form the Swastika, meaning "bringer of blessings," which goes back in India to the seventh century, when it was used as a cattlemark. Another reference is well before 528 B. C. It is found on gold leaf on a vase with relics of Buddha, and it appears on the Edicts of Asoka (273-232 B. C.). The earliest example known is on a spindle whorl from the third city of Troy, about 1800 B. C., and it is frequent in Greek vases about 600 B. C.

Discovery of the Tomb of Herod's Cousin.—It would appear that Herod's cousin was not very much of an object for archaeological inquiry, but it seems so. The burial place of Antiochus has been found by explorers of the Museum of the University of Pennsylvania, at Beth Shan, in Palestine. In all probability Antiochus was one of the men charged by Herod with directing the slaughter of the children of Bethlehem. No discovery which has been made in the Near East in a long time compares with this. Levels of six cities have been found so far at Beth Shan, and it is known there are more below. The site is said to have been occupied for a longer continuous period than any other place of human habitation. It was also the most fought-over spot in the world, since it commands the gateway between Mesopotamia and Egypt and was necessary to the conquest of Palestine. Crusaders fortified the hill, and General Allenby took it from the Turks in the World War.

To Dig Up "Ur of the Chaldees."—Ur of the Chaldees, ancestral home of the Patriarch Abraham, is to be explored down through the dust of centuries to the earliest records by experts of the British Museum and the University of Pennsylvania Museum, Dr. G. B. Gordon, director of the University Museum, announced recently. Dr. Gordon has just returned from a trip in which he made arrangements for the joint expedition and saw the explorers start for Southern Mesopotamia. Bible scholars and authorities on the early history of mankind, embracing half a dozen sciences, greeted the announcement with declarations that the attempt to wrest from the ruins of Ur the secrets of the city's antiquities is the most important archaeological effort of the last century. The two museums will share equally in all finds. Heretofore no systematic digging has been done at Ur, yet great libraries of cuneiform texts have been assembled at the two museums from material picked up near Ur by Arabs and passing explorers. The information obtained from these sources was said to show conclusively that the ruins contain thousands of tablets with important records.

Electrical Notes

Summaries and Excerpts from Current Periodicals

The Electric Taxicab.—Despite all the improvements that have been brought about in the gasoline automobile, the electric automobile still survives, even if it is not very different from its earlier models. And the best proof that the electric automobile is by no means extinct is to be found in a large fleet of electric taxicabs which has been put into service in New York City. These electric taxicabs have the same lines as the usual gasoline taxicabs, including the hood underneath which is placed the storage battery.

Doing Away with Solder.—In all forms of electric wiring it has been the practice to solder all joints and connections in order to insure reliable and permanent circuits. Of late various forms of electrical connectors have made their appearance on the market, having for their object the elimination of solder. One of the most popular forms of connectors is a tiny bit of square tubing provided with two screws. Wires to be connected together are inserted into the opposite ends of the square tubing, and the two screws are screwed down tightly. The connectors are then taped in the same manner as a soldered splice or joint.

A Table Fountain driven by an electric pump has now made its appearance. A small universal electric motor drives a centrifugal pump which forces the water in a pan into the 12-inch spray ring and out in the form of sprays from 50 spraying nozzles. The motor and the pump are placed under a glass dome, which is attractively illuminated by two electric lights. A special rheostat takes care of any variation in the electric current and also controls the height of the sprays. The lights are also controlled by means of this rheostat device, quite independently of the sprays. The pan contains about three quarts of water and measures 20 inches across by about two inches deep.

An Electric Coal-Conveying System.—According to the *Bulletin Oerlikon*, an unusual electric conveying system has been installed for the purpose of filling automatically the coal bunkers of the power house of a large steel mill. The buckets each hold 900 pounds of coal, and run underslung along an elevated rail system. The two running wheels are driven by a small direct-current motor, which collects the current with a short trolley pole from a 110-volt overhead wire. The average speed of the bucket is 300 feet per minute, and there are curves as small as 6 feet radius to be passed. The total traveling distance of the buckets is 1320 yards, arranged in the form of a closed loop. As there are six buckets traveling, a total of about 11 tons of coal can be conveyed hourly. An interesting automatic blocking system is used to prevent collisions between the buckets.

Electrical Prospecting.—Any mineral mass which possesses metallic electrical conductivity throughout a sufficient depth and which lies underground in such a fashion that part of it rises above the water table produces in the surrounding moist terrain electrical currents observable by the differences of potential which they produce. This principle, according to a recent article in *Engineering and Mining Journal-Press*, is the basis on which experiments in electrical prospecting were carried out. The entire phenomenon is explained, as is the manner of utilizing these currents to determine the presence of minerals. The results of field work in various metal mines in the United States and Canada made by the author are presented. The most important application of this method is its value in the preliminary determination of advantageous locations for diamond drilling. Coal is also subject to satisfactory tests.

Electricity to Conserve Fodder is one of the later-day uses for electric current, according to a recent account in the *Elektrische Kraftbetriebe und Bahnen*. The author, Dr. Bockelmann, recommends the general use of the electric method for fodder conservation, not only because it is efficient, but because it is simple enough to be readily carried out at a slight expense. At the bottom of the silo a large steel plate is placed, connected to one pole of the electric supply, which can be 200-volt direct current or 220 to 380-volt alternating current. The silo is then filled with cut greens, on the top of which rests a heavy wooden cover lined on its under side with zinc. This cover forms the second electrode. The current is adjusted to about 50 amperes. The passage of the current through the fodder will heat it until a temperature of 50 degrees Centigrade has been reached, at which the conservation process is finished.

Flexible Cords come in various weights and insulations ranging from the simple twisted lamp cord to the heavy reinforced super-service cords for portable electric tools. There is, for instance, the so-called Brewery cord, which comprises stranded tinned copper conductors insulated with seamless rubber and covered with black weather-proof braid. The two conductors form a twisted pair. Then there is another cord which has additional black weather-proof braid on brewery cord, to protect against dampness. Packing-house cord has a jute filler and two weather-proof braids added to brewery cord. Deck cable has seamless rubber insulation between the filler and the braids of packing-house cord. Heater cords have extra flexible conductors covered with plain cotton, insulated with rubber compound, braided asbestos fiber, finished with gray or black glazed cotton outer braid. Super-service cords have rope-stranded copper conductors, cotton-wound, insulated with rubber compound, covered with cotton braid or tape. These conductors are cabled together with cotton cords, covered with two layers tire-tread rubber, cord insert between layers. The completed cord is vulcanized in molds under compression. These cords are made in two, three and four conductor styles.

Ore Detection by Electrical Methods.—From time to time there have appeared various methods for the electrical detection of mineral deposits. Some of these methods have been out-and-out quackery, intended to separate credulous individuals from their money. Others have been serious efforts based on the increased conductivity of terrain abounding in mineral deposits. The most recent method which appears to be worthy of consideration is that of two Swedish engineers, Harry Nathorst and Hans Lundberg. Their method is based upon the observations of two Englishmen, Daft and Williams, that ores, which are better electric conductors than the surrounding rocks, produce strong disturbances in an electric field existing within the area in which they occur, and that such disturbances, although they mostly take place in depth, nevertheless are to a certain extent reflected in the flow of the current on the surface. Thus it is possible by observations on the surface to determine the existence of ores lying in depth and at the same time to determine their position and approximate extension. The present method calls for the production of the necessary electric field in the area to be investigated. For this purpose a fixed primary circuit is employed, consisting of two poles or electrodes and of two conductors connected to a source of current. In this method of ore detection the electrodes are formed of long galvanized steel ropes, which for convenience of handling are divided into lengths of 150 feet or more. In order to produce good electric contact with the ground, these ropes are fastened to steel spikes which are driven into the ground at regular distances apart. Electrodes of this type are called common linear pole or line electrodes. The conductors consist of ordinary insulated copper wires. The source of current consists of a little hand or power driven generator, which produces single-phase alternating current with a maximum tension of 220 volts. For finding the level lines a movable secondary circuit, the so-called searching circuit, is employed, consisting of two iron rods with insulated handles, the so-called searching rods, connected with each other by insulated copper wires, to which a telephone is coupled. Usually it is most convenient to employ a telephone helmet with double ear pieces, which can be coupled in series or in parallel according to circumstances. The result of this electrical survey is a chart showing the varying electrical conductivity of the terrain covered, and indicating the possible ore deposits which cause certain irregularities in the electrical conductivity.

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Automobile Notes

Skidding.—Without at all deprecating the use of chains, it is proper to observe that the extremely vicious skidding of a decade gone is no longer with us. No one who recalls the gyrations of former years when automobile and slippery pavements met can fail to realize that the development of tire treads that really grip the road has gone a long way.

Size and Speed of Trucks.—A traffic census taken by the Bureau of Public Roads on a much-traveled New England highway answers the question, "How large is the average truck and how fast does it travel?" Forty per cent of the trucks were of 1-ton capacity or under, 33 per cent between 1 and 2½ tons, 5 per cent between 2½ and 5 tons, while less than 2 per cent were of more than 5 tons. On a level stretch of road more trucks traveled at 20 miles an hour than at any other rate; 37 per cent traveled at a higher speed.

Five-Bearing Crankshafts.—With the higher speeds of the engines of the day, it is found that the four-throw crankshaft with three bearings has a pronounced tendency to whip. The effort to overcome this with bigger bearings and journals is not particularly satisfactory. The ideal bearing, for a member subject to the torque of a crankshaft, is a single line or point; and the wider we make the bearings, the greater the twisting and binding effect of the torque. The present tendency of new practice seems rather distinctly to be toward the use of five bearings with the four-cylindered engine of extreme speeds and it seems a safe prediction that we shall see more examples of such design every year.

Wrecking a New Highway.—A new Government road two and a half miles long is to be broken up, in the most extensive study of road service ever undertaken in this country. This Illinois road has grades varying from zero to four-tenths of one per cent; there are seven general types of paving represented, so that engineers may study the effect of known and measured traffic upon each kind of material. Since the road's completion the effects of heat, cold and moisture have been carefully noted; now it will be subjected to rigidly controlled traffic by a battery of 10 motor trucks. The number and weight of loads required to produce failure in the different sections will provide an index to the endurance of various paving materials under different stresses, and the resulting knowledge will be of incalculable value.

A Starting Wrinkle for the Flivver.—Owners of the ever-popular Tin Lizzie are confronted with one aspect of the winter-starting problem that does not worry the owner of a car with a gear-box. If the transmission bands and clutch are sufficiently tight to give satisfactory speed-changing, there is no clean-cut neutral position of the clutch. The setting of the hand-brake remedies this very nicely in warm weather, and takes the drag of the rear axle off the starter. But when the oil congeals overnight the story is quite different. The trick that largely overcomes this is to leave the car standing in low gear over-night; and in the morning, first of all, bring it back to neutral by jerking the hand-lever up as violently as possible. This breaks away the congealed oil film more effectively than turning the engine over by hand ever can.

Cooling Control.—Somebody has suggested that the installation of thermostats, shutters, etc., is a confession of weakness; that a properly designed cooling plant ought to cool the car without the necessity for tinkering with it to meet the vagaries of the weather. The fact is, of course, that overcooling is just as objectionable as constant boiling; and that the only way in which a proper mean can be maintained is by a system that modifies its cooling capacity according to the weather. At the same time, the thing can be carried to an unnecessary degree of fineness. During the season when thermostats are busy and shutters working overtime, while those who do not possess these gadgets fall back mainly upon the use of newspaper and cardboard shields over the lower part of their radiators, the driver whose front-end design makes it possible for him to slip off his fan belt will be able to achieve much the same result in this way, and with a saving of power. Why burn up gasoline in driving a fan at 1000 revolutions and upward, and then worry about means to prevent the action of this fan from overcooling the engine?

John J. Pershing, General of the Armies of the United States

(C) International

Steam Turbines as Motive Power for Aeronautics

RECENT developments with the steam turbine, which have been made by German engineers, have raised the hope that the turbine may also be used for driving flying machines. In early days of aeronautics, before the perfection of the modern internal-combustion engine, steam engines were used in flying machines. The best-known construction was that developed by Hiram Maxim, who installed a 300-horsepower steam engine in his multi-deck flying machine. It will be recalled that this machine was wrecked in the first attempt to fly. Since that time considerable progress has been made in the design of steam engines, not only from the standpoint of structural refinement but also with regard to the sparing consumption of steam and combustible. But when the gasoline motor came upon the field, it was readily believed that the steam engine was relegated to the discard once for always as far as the driving of flying machines was concerned.

However, the work of the German engineer Wagner, stretching over a period of years, in perfecting the design and construction of the steam turbine, has again brought to the attention of the aeronautic industry the possibility of using steam-driven engines in flying machines. Wagner has been successful in developing machines of light weight and in building special forms of turbines which, when operated with high pressure steam, will fulfil all the requirements that are demanded of flying machine motors. One problem, which was especially difficult to solve, was the construction of air-cooled condensers, which not only must not have too great air resistance for aeronautical purposes, but which must also not be too heavy. In any case, however, the condensers form from 20 to 30 per cent of the entire weight. On the other hand the steam turbine may be driven for a long time under a load, which is a third greater than the normal, and furthermore its effective operation does not depend on the density of the air as is the case with internal-combustion engines. There is no decrease in the potential power of the steam turbine when the flying machine reaches the upper regions of the air. For this reason the height to which the flying machines can rise, when driven by steam turbines, is almost three times as great as that which can be attained by machines which are propelled by gasoline motors, all other conditions remaining the same. Furthermore, at the higher altitude the speed of the machine is correspondingly greater due to the reduced resistance of the air.

The use of turbines for driving flying machines in the place of cylinder engines possesses the important advantage that in the former case the motion produced by the driving device is pure rotary motion free from all shock, while in the latter case there is always the shock of the explosion within the cylinder and the intermittent effect of the falling masses of the cylinders to be reckoned with. The use of steam turbines hence renders it possible to construct the framework of the machine of lighter material, as under these conditions it is not called upon to withstand the shock of driving engine.

From the economic standpoint the use of steam turbines is important because such fuels as tar oil, mazut and similar materials can be used in the generation of the driving fluid, steam. These materials are much cheaper than gasoline or other composite motor fuels, about five to six times cheaper. Furthermore the steam turbine operates with a much greater degree of safety and similarly it possesses a longer life than the internal-combustion motor.

While practical tests with the new steam turbine in driving flying machines are not yet available, it is hoped that they will be forthcoming in the near future. It must be remembered that the steam turbine rotates at a speed of 25,000 to 30,000 r.p.m., and that this speed must be reduced to about 1500 r.p.m. Then again there are the various auxiliary machines, such as steam superheater, feed water and air heaters, feed pumps and fans to be considered. Each piece of apparatus must be made as light and as efficient as possible to be used on flying machines. As far as the speed of the flying machine, equipped with steam turbines, is concerned, there need be no doubt that it will be very great. Practical tests on suspended mono-rail railroads have shown that a speed of 300 kilometers can be attained without difficulty.—*Abstracted from Die Umschau, Aug. 26, 1922.*

Lighthouses

THE early lighthouses were lighted with open fires, and tallow candles were used at the Eddystone light for more than a hundred years. Although lighthouses have aided the mariner for more than 2000 years, most of the progress in illuminating apparatus and fog signals has been made during the last century. A hundred years ago coal fires and tallow candles had only recently been abandoned at important lighthouses in England, guns were still used as fog signals, and no outside lightship had yet been moored off the coast of this country. The French physicist, Fresnel, in 1822, a hundred years ago last year, made the greatest single step in the improvement of illuminating apparatus by developing a built-up annular lens surrounded by rings of glass prisms, the central portions of which refract and the outer portions both reflect and refract the light from a single source lamp placed at the focus. This lens was for a fixed light, and its effect was to concentrate the light in a plane useful to the mariner, but distributed around the horizon. Great progress has since been made by the use of lenses constructed in panels, and rotated, thus concentrating the light in beams sweeping around the horizon, and showing the mariner a flash or group of flashes with definite characteristic. Great illuminating efficiency and much reduced cost have been obtained with such apparatus, by using smaller lenses, concentrating the light through a small number of panels, and revolving at high speed. The latter is made possible by carrying the weight of the rotating lens in mercury in an annular trough. The following comparison shows the great advantage of the modern lens arrangement: At Seguin, Maine, with first order lens 72 inches in diameter, the light, which is fixed, has 22,000 candlepower. At Molokai, Hawaii, there is a second order two panel lens, 55 inches in diameter, revolving once in 20 seconds, and giving each 10 seconds a flash of 620,000 candlepower. At the latter the cost of oil per candlepower per year is only about one-thirtieth of a cent. With the most complete lenses about 60 per cent of the light is rendered useful, the balance being lost at the top and bottom, and through absorption by the glass of the lens and lantern.

Most of the important lights, and a large proportion of all the lights, have distinctive characteristics, to avoid the serious danger of mistaking the identity of the light. Color is used to some extent, but is undesirable excepting for minor lights because of the large loss of light, about 60 per cent, even with the most efficient color, red. Modern installations at important stations have distinctive characteristics through the use of revolving lenses. Older installations of fixed lights have been changed into occulting by the use of some form of moving shutter or screen, much less efficient optically than the revolving lens, as the light is not concentrated into beams. Acetylene gas and electricity lend themselves to efficient arrangements for flashing lights. With the former, a small pilot flame burns continuously, and an ingenious flashing device discharges a supply of gas from the tank at uniform intervals of time.—*Abstract from article by G. R. Putname in the Journal of the Washington Academy of Sciences for June 19, 1922.*

Ants Preserved in Amber

IN the *Scientific Monthly* for June, 1922, Professor W. M. Wheeler of Harvard University, gives an account of the preservation of ants in amber for several millions of years.

Some years ago the museums of Konigsberg and Berlin sent Professor Wheeler an extraordinary collection of ants in lumps of Baltic amber. There were 9560 specimens, representing 92 species and 43 genera. Baltic amber is merely the fossil resin of pines which flourished during Lower Oligocene Tertiary times in the region which is now Sweden. The liquid resin exuded from the tree-trunks precisely as it does today, and great numbers of small insects, especially ants, were trapped in the transparent, viscid masses which hardened, fell from the trees or remained after the rotting of the wood and were carried down by the streams and embedded in what is today the floor of the Baltic Sea and the soil of Eastern Prussia. The lumps are now brought to the surface either by mining or by the action of the waves which cast them up on the beaches. So beautiful and lifelike are the insects preserved in the amber that by comparison all other fossils have a singularly dull and inert

appearance. Many of the specimens which Professor Wheeler examined were as exquisitely preserved as living ants embedded in Canada balsam by some expert microscopist. Study showed conclusively that the ants have undergone no important structural modifications since the Lower Oligocene, that they had at that time developed all their various castes just as we see them today, that their larvae and pupae were the same, that they attended plant-lice, kept guest-beetles in their nests and had parasitic mites attached to their legs in the very same peculiar positions as in our living species, and that at least six of the seven existing subfamilies and many of the existing genera were fully established. Some of the species in the amber were even found to be practically indistinguishable from those now living in Northern Europe and North America. Professor Wheeler concludes, therefore, that these insects had their origin in the Cretaceous, if not earlier. This means that all the main structural and social peculiarities of these insects were completed by the beginning of the Tertiary and that they have since been merely marking time or developing only the slight modifications which serve to distinguish genera, species, subspecies and varieties.

How many years have elapsed since the beginning of the Tertiary? Geologists have, of course, made many and diverse estimates. Barrell gives the time since the beginning of the Tertiary as 55 to 65 million years. But the social insects are the most recent—the mere newly rich, so to speak—in the great class Insecta, which has a fossil record extending back to the Upper Carboniferous.

The Coal Ration

(Continued from page 77)

filtration plant from which the household got its water.

But even this is by no means the extent of the unseen domestic service rendered by coal. Perhaps half of the things we buy at the store for the table have required coal in their preparation—sugar, bread, every canned article. In such invisible form it is estimated that more than 10,000 tons of coal come each day to our tables. To this extent coal is a food necessity. But even more is coal the staff of life of American industries. Every ton of steel produced has cost two tons of coal, every ton of cement has cost half a ton of coal, even the newspaper or magazine has cost more than twice its weight in coal. In short the average man with an average family of five, buys 30 or 40 tons of coal each year rather than the mere fourteen tons which on the average he burns in his own home.

The Census of the Stars

(Continued from page 79)

to South Africa, completed a series of 206 charts 15 degrees square, and among them covering the whole heavens, and showing stars to the sixteenth or seventeenth magnitude. On the original plates of this series the number of stars shown per plate (as estimated from countings on selected portions) ranges from 60,000 in the poorest parts of the sky to over a million in a few of the regions of the Milky Way. Even allowing for the loss in copying, these charts must show a total of twenty or thirty million stars.

A second set, showing even fainter stars, but not extending over the whole heavens, has been prepared by Wolf of Heidelburg and Palisa of Vienna. The charts of both these series have been reproduced and sold to observatories at little more than the cost of the photographic prints. The latest quotation on the English series was twenty pounds sterling for the set—say two thousand stars for a cent!

The astronomer who has a set of these charts can identify any star that can be seen with any but the very greatest telescopes by marking it upon the chart, or upon a photograph or tracing of the chart. A printed catalog of these many millions of stars would fill hundreds of volumes and be prohibitively costly and cumbersome; but fortunately it is quite unnecessary. Our photographs give us all we require, at a relatively insignificant cost.

They do even more than this: they help us to pick out, from the undistinguished millions, just the few stars which are of interest for special reasons—for example, those which vary in brightness, or which show perceptible proper motions among their neighbors. A beautiful apparatus known as the blink microscope does this selection, almost by machinery. Two plates of the same region, taken with the same telescope, a few years apart, are mounted in such a way that the corresponding parts of them are viewed by two microscopes with a common eyepiece. By shifting a tiny mirror, first one and then the other set of images appears in the field of vision. When the plates are properly adjusted, this shift from one plate to the other does not appear to displace the star images—at least, not the general run of them. But if some one star out of the thousands has changed in brightness or position, its image will appear to grow and shrink, or to jump, as the "blink" lever is worked back and forth; and so it can be instantly picked out.

Finally our photographs enable us to go back in time, and observe what happened in the past—provided only that we have a plate of the desired region of the heavens, taken years ago. Preeminent in this respect stands the great Harvard Library of photographs—about a quarter of a million of them, covering all regions of the heavens. Under the sagacious direction of the late Professor Pickering, photographs have been made with instruments of various size and power at frequent intervals all through the last 30 years; so that, if any star brighter than the twelfth magnitude is picked out at random, there will be two or three hundred plates on which it is shown. For fainter stars the number is fewer, but the record is still fairly complete. All these photographs are carefully stored and indexed, so that those including any given region of the sky can readily be found.

If now any new event occurs—such as the sudden outburst of the brilliant "new" stars in Aquila in 1918 and in Cygnus in 1920—the Harvard observers examine their old plates and in a few days we hear all about what that star has been doing for the past two or three decades. For example, Nova Cygni, before its outburst, was excessively faint, while Nova Aquilae was of the eleventh magnitude, and slightly variable.

An instrument which will observe tens or hundreds of thousands of stars at once, and make a permanent record of its findings, is indeed a mighty aid; and it is to photography more than to anything else that present-day astronomers owe the good fortune that they can not only chart the faintest stars, and tell one another where to look for them, but can pick out the one interesting object in a thousand, and even can make valuable observations of stars which they do not know are there, and do not discover until years afterwards.

A Turbine Locomotive Which Saves Half the Coal

(Continued from page 91)

420 r.p.m., the brake horsepower being 1800. The second element of the reduction gearing carries at its ends two cranks which are coupled by connecting rods to the six-coupled driving wheels.

Reversing is done by means of an idle pinion, which is carried between the pinion on the turbine shaft and the last gear of the drive. The idle pinion is moved radially so as to engage both gears. The movement is effected by oil pressure acting on a spring controlled piston.

Now since the condenser has to handle some 20,000 pounds of steam per hour, it is evident that the condensing plant must call for a large element of special construction. It would have been practically impossible to use water-cooling, because either an abnormally large supply of cold water would have had to be carried, or frequent stops would have been necessary to replenish the supply. Therefore, Mr. Ljungström decided to follow automobile practice and build a radiator of large proportions. The condenser consists of a rectangular, plate-steel, closed housing, built to the full limit of the loading gage. Its two sides are pierced with vertical louvres so shaped as to draw within the condenser a continuous supply of cold air. Running longitudinally within the housing are two cylinders, a large lower cylinder, and above it and connected to it by vertical pipes a smaller cylinder, each of which extends the full length of the condenser. The lower condenser is usually about half full of hot water and forms a reservoir from which the feed water is pumped to the boiler. The roof of the condenser consists of a large number of copper tubes, so shaped as to secure the maximum of cooling surface. They run transversely and occupy the position of the rafters of an ordinary roof. The cold air which enters by the side louvres is driven up against and between the above mentioned nest of condenser tubes by means of three large fans driven by a steam turbine, and the condensed steam passes from the tubes to

collect in the larger cylinder below. The whole area of the copper condensing tubes is 9000 square feet. The water is pumped to the boiler by a condensate pump, turbine-driven, and before reaching the boiler it passes through three successive feed heaters in series, finally entering the boiler at a temperature of 150 degrees Centigrade.

Another interesting feature of the locomotive, which like the radiator system turns our thoughts to the automobile, is the fact that the running parts of the locomotive, including the reducing gears, cranks, coupling rods, etc., are completely enclosed to protect them from dirt and ashes, and that forced lubrication is used. As will be seen from one of our photographs, the connecting rods on the driving wheels are completely shut in from sight. This has the advantage that there is a great saving of oil, and an even greater saving of wear. Consequently, the locomotive can make much longer runs without repairs than are possible with the standard type of locomotive, whose parts are entirely exposed. It has been found that in this respect there is a great saving both in time and in maintenance.

The new locomotive has been through exhaustive tests, both over a testing pit and in hauling fast passenger trains in competition with the standard Swedish simple locomotives, and it has shown truly astonishing economy. An analysis of its performance shows that out of every 100 heat units 18 per cent are lost in smokestack gases, hot ashes, etc., 3.5 units are lost through radiation and by leakage through the stuffing boxes, etc.; that 3.3 units are consumed in driving the condenser fans, and that 60.5 heat units are rejected to the condenser; this leaves 14.7 units available for useful work, and 14.7 units would be considered a good performance in a well found stationary plant. This 14.7 per cent of work in the turbine locomotive should be compared with the average thermal efficiency of the simple locomotive of, say, 6 per cent.

In conclusion it should be noted that the maximum starting draw-bar pull is 13.5 tons when the rails are in good condition. This may be compared with the starting draw-bar pull of the latest and most powerful standard express engines on the Swedish state railways, which is 9.3 tons.

The testing pit and service runs of this locomotive have shown, as compared with the standard reciprocating locomotives of the Swedish railways, that it will do the same work with 50 per cent less fuel consumption; second, that the running maintenance is reduced; third, that the draw-bar effort at starting is greater and slipping of the wheels is reduced; fourth, because of its economy either more coal can be carried, or smaller bunkers may be used, as desired; fifth, that the conservation of water due to condensing renders stops for water less frequent; lastly, it is possible to build within the standard loading gauge a locomotive far more powerful than can be built of the reciprocating type. This is particularly true of the United States where, in the opinion of the designer, it should be possible to build locomotives of 6000 horsepower.

The New Conservation—III

(*Continued from page 98*)

market places of the world, it behooves us to understand and to practice simplification. It is not historically new, but it is the newest service to American industry. Secretary Hoover believes there is a very pressing need for minimizing the present spread between costs for raw materials and prices of finished products, for maintaining our standards of living while reducing the cost of living, and for broadening our markets. Much can be done to secure these results by the cooperation of the American public toward eliminating waste in industry.

Saving by intelligent spending is the most desirable form of thrift, but spending with a waste of nearly 40 per cent of our productive energies, as revealed by the recent assay of waste in six major industries, is neither thrift nor common sense.

In the present coal and railroad crises, we have again approached war-time conditions. Fuel is rationed, industrial operations are being curtailed, shortages will occur in supplies, and prices will undoubtedly rise. The cost of living will start on another upward course, and other conditions similar to those of 1917-1919 will develop.

Then we simplified our manufacturing, our selling, and our daily living in order that the nation might be preserved from foreign invasion. We are facing another invasion now, not of Huns, perhaps, but of foreign goods, lowered standards of living and woeful want. Simplification, interpreted as the intelligent conservation of all our resources, offers one way out of our present maelstrom. The Department of Commerce offers the services of its division of simplified practice to all business men, interested in reducing waste, improving business, and enjoying greater prosperity.

Thawing Water Pipes

WHEN the lights fail, one almost instinctively phones to the lighting company, and in a short time the illumination is restored—at least, such attention is expected and so far as feasible is generally accorded. When the water supply fails by reason of frozen pipes or the gas is cut off by the freezing up of the supply, relief may be sought from the same source—the lighting company.

In the progressive community, pipe thawing is not considered an unusual service to ask of the lighting company, but in many other places the idea would never occur to the harassed householder. A plumber is called or efforts made to thaw the pipe with hot water, by building a fire under a fancied frozen section, or by some other usually ineffective means. Even if finally effective, these home remedies are nearly always long drawn out and expensive—as may also be the services of the plumber—for the stoppage is very apt to be outside the building, somewhere between the entrance to the house and the pipe connection to the water main, where one cannot get at it without laborious excavation.

The lighting company can do the work with the consumption of some of its electric energy in a few minutes, without danger to building or piping, and no more manual exertion than required to make a few simple electrical connections. Furthermore, it is not essential for the inflicted house to enjoy the conveniences of electric service, provided it is within a reasonable distance of the lighting company's plant. This means there are several ways of thawing pipes electrically.

If the house is supplied with electric service or is in proximity to the distributing lines of the lighting company, the necessary energy is drawn from these lines, but if removed from such sources of supply a portable generating plant or storage batteries mounted on a truck can be utilized—provided, of course, such a useful piece of equipment is maintained by the lighting company, or by some enterprising contractor. With the distributing lines available, a truck or other vehicle is also required, to transport the paraphernalia needed for the thawing operation.

This thawing plant, in the case of an alternating current service supply, consists of transformers with some voltage regulating control and leads of generous length for making the necessary electrical connections. The transformers should have a capacity of 15 to 25 kilowatts, for current up to 500 amperes at 50 volts potential may be required. The matter of voltage is important, for upon it the efficiency with which the thawing can be consummated is largely dependent. For economy in use of electric energy, it should be kept as low as possible, for the heating effect of the electric energy is a function of its amperage, not its voltage. The voltage need be no heavier than necessary to overcome the resistance of the pipe to the passage of the current, so completing the electric circuit. This will vary with the length of pipe between the points at which the electrical connections are made and, strange as it may seem, is usually less for a severely frozen pipe than for one which is imbedded largely in unfrozen ground.

The primary leads from the transformer are connected to the distributing supply lines of the lighting company, one of the secondary leads to a faucet or other convenient pipe connection in the house and the other secondary lead to the nearest fire hydrant or other outcropping valve outside the house. The voltage of the utilized current is regulated to complete the secondary circuit, a faucet opened and within a few minutes the water is running freely.

If the house is supplied with direct current, a resistance bank is substituted for the transformers of the alternating current thawing plant, but the modus operandi is no different. Where no electric energy supply is obtainable, a portable thawing outfit, entirely self contained, is a development already found in a number of communities where the demand for such equipment warrants its construction. A gas or oil engine is employed to drive a low voltage electric generator of adequate capacity, or else a

battery of storage cells is mounted on a truck. In either case, the actual thawing of the pipe is conducted after the manner described for thawing outfits operated from the lighting company's distributing service lines.

This is only one more of the numerous services for which the advice "Do It Electrically" can well be urged.

Radiant Heat—What It Is and What It Does

RADIANT heat is more or less a novelty in heating methods and, for that reason, is not understood by the general public. Laymen seem to think that there is only one kind of heat, whereas there are three distinct methods of transmitting heat, namely, convection, conduction and radiation.

Convection is the heat with which we are more or less familiar. It is the heat obtained from our steam heat radiator and hot air furnace. With this type of heat the cold air comes in contact with the hot surface and as hot air rises, more cold air takes its place and gradually the air is circulated around the room until the room is warm. This type of heater heats the air, and the air, in turn, heats the different objects such as tables, chairs, walls, and so on in a room.

Conduction is the heat that passes through metals. Put a piece of iron into a fire and the heat is conducted through the metal to your hand. In the conduction method the heat passes from the hot end to the cold end, regardless of whether the metal is held vertically, horizontally or in any other way.

Then we come to radiant heat, which is only now being put to extensive use. With radiant heat we have a law that tells us that radiant heat will pass through air without heating it, but will heat objects it strikes. This type of heat we get from the sun or an open fire-place. In the open fire-place the burning wood requires air for its oxygen to keep it burning. The smoke goes up the chimney and therefore we have a movement of air from the room to the open fire-place and up the chimney. As all the air is moving toward the fire-place and the hot air rises, how can an open fire-place heat a room? The only way it can throw out heat is by radiant heat. The fire sends rays of heat out into the room. They pass through the moving air and warm the chairs and other furniture and the persons gathered in front of it.

The sun's rays pass through the air without heating it, but warm the crust of the earth. The cold air strikes this heated surface and is warmed. Thus we have seen the sun melt snow where the sun was shining, and a few inches away in the shade the snow would be freezing. A thermometer directly in the sun's rays would be registering 80 degrees. Of course there is not that discrepancy in the temperature of the air, and the fact can be readily proved by holding something in front of the thermometer to shield it from the sun's rays. Immediately the mercury starts to drop.

The most interesting application is the radiant type of electric heater, now so popular in homes, offices and stores, especially since the coal shortage. In this form of electric heater we consume about the same amount of electricity as is the case with the usual electric toaster or electric iron. Yet the electric toaster or the electric iron will not heat a room. Still, by using the same amount of current and placing the same amount of heat units in front of a copper reflector, we are able to produce radiant heat and warm persons or objects at a distance of 5 to 7 feet away with little difficulty.

An electric fan may be placed at right angles to the radiant heat beams and blow a breeze between the heater and the persons enjoying the heat. Radiant heat will pass through moving air without heating it, so that the fan will have no effect. Still more striking is the radiant type electric heater demonstration of a large electric manufacturing company, in the shape of a motor truck on which is mounted an enormous electric heater. Despite the wind and cold, this electric heater, measuring over four feet in diameter and using enough current to light a dozen large houses, readily warms passers-by on the sidewalk from a distance of 25 to 50 feet.

The radiant electric heater may be compared with a searchlight in that the heat rays, like the light rays, are concentrated and directed to the desired place. If a person steps into the invisible heat rays, he is warmed; if he steps out of the beam, he is cold. As the object of the radiant heater is to furnish a heater that will supply comfort immediately and locally, it serves a purpose that is left unserved by all other forms of heat. Radiant heat has made electric heating practicable as an auxiliary to other forms of heat.

The World's Largest Vehicular Tunnel

(Continued from page 109)

working chamber, and vice versa. At the front end of the chamber is the shield, which is nothing more or less than a great steel cylinder 18 feet in length and 31 feet in diameter. It consists of an outer and inner ring, braced together by longitudinal and transverse diaphragms, and further stiffened and strengthened by two vertical and two transverse diaphragms, which extend for its full length and divide it into nine separate rectangular pockets. The shield is of slightly larger diameter than the finished cast-iron tunnel, and its after portion overlaps the tunnel, as shown in our drawing.

The shield, which with its hydraulic machinery weighs about 400 tons, is shoved forward about 30 inches at a time, by means of 30 hydraulic jacks which are set up circumferentially in the outer ring structure of the shield. These jacks have an ultimate, combined shoving power of at least 6000 tons, and by varying the pressure in the jack the shield may be guided so as to maintain the proper line and grade. The completed cast-iron tunnel forms an absolutely solid abutment for the thrust of the hydraulic jacks.

After a forward movement of the shield the next cast-iron ring of the tunnel is erected by means of a swinging hydraulic erecting arm, which picks up the segments from the cars on which they are brought forward, and swings them successively into place, where they are bolted up to the existing structure.

Projecting from the upper part of the forward end of the shield is a steel hood forming a protective roof or cover, under which the laborers with pick and shovel excavate the material and shovel it into a hopper which delivers to a traveling belt, from which it is transferred to muck cars and taken out of the tunnel. Another opening is shown at the lower face of the shield through which also material may be excavated into the tunnel.

We have spoken of the provision for continuous and rapid operation which is necessary in a work of this magnitude; and in this connection we direct attention to the special three-deck traveling, working platform. This is a massive structure of steel and timber, which extends the full width of the tunnel, and runs by means of rollers upon tracks, carried on stout brackets at the sides of the tunnel. On the floor of the tunnel are three tracks for the operation of the cars which bring material into and out of the working chamber. The muck cars come in on the center track and are loaded at the inner end of the belt conveyor mentioned above. Over the center track is an elevator on which the cars loaded with cement are lifted to the top platform. Here the cement is dumped through a hopper into a mixing machine, which is fed with the right amount of water to produce the grout with which the outside of the tunnel is grouted up. The grout is fed by hose to holes, drilled for the purpose through the shell of the casing, where it fills up any voids between the casing and the surrounding material. The cast-iron segments are brought in on small flat cars, and picked up and put in place by the hydraulic erecting arm to which reference has already been made.

It should be noted in conclusion that, in order to prevent accidents, due to blowouts caused by the pressure of the air within the working chamber overcoming the inward pressure of the silt, it will be necessary to dump in the river bed for the whole length of the tubes, and for a width covering both tubes, a great bed of clay and riprap, which will be about 10 feet in depth and will approximate about 200,000 cubic yards of material.

As we have already noted, the first caissons on the New York side have been sunk and the tunnel is being driven forward. The Jersey land caissons are erected and being sunk to the permanent grade, and the work will be prosecuted with such vigor that it is expected that the whole tunnel will be completed by January 1, 1926. We conclude by expressing our indebtedness to Mr. E. Morgan Barradale, assistant to the chief engineer, for courtesies rendered during the preparation of this article.

Why the Finish on the Fenders Lasts so Long

Automobile builders had to learn to do many different kinds of things—and to do them well. An automobile is the composite product of many allied crafts.

The matter of finish is one that has had to be worked out; and so far as fenders and similar metal parts are concerned, electric heat has found the answer. Your fenders are enamelled, and the enamel is baked on electrically; which means just the right temperature, applied for exactly the correct length of time, as well as the absence of dirt and air currents and other conditions which interfere with a perfect job. The finish on the fenders of a good car lasts a long time because electric heating apparatus makes such good work of the enamelling process.

Cadillac, Packard, Paige and Jordan are among the automobile builders who use Westinghouse Industrial Heating apparatus in their enamelling departments.

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